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HANDBOOK

OF THE

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MARKS VI TO VIII,

ON

TRAVELLING CARRIAGES.

1920.



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[Issued with Army Orders for June, 1920.]

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# HANDBOOK

OF THE

## B.L. 8-INCH HOWITZERS,

## MARKS VI TO VIII,

ON

## TRAVELLING CARRIAGES.

---

1920.

---



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This Handbook is corrected up to May, 1920. Any alterations which may be suggested should be sent to the Chief Inspector of Armaments, Inspection Department, Royal Arsenal, Woolwich.

40  
W.O.  
7877

Issued with Army Orders for March, 1921.



**CORRIGENDA No. 1 TO HANDBOOKS FOR  
THE FOLLOWING EQUIPMENTS.**

B.L. 6-inch 26-cwt. Howitzer, Mark I, on Mark I Travelling Carriages (Plate VI).

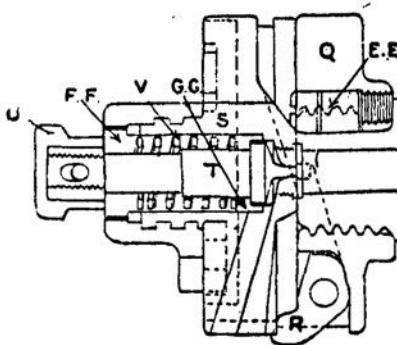
B.L. 8-inch Howitzers, Marks VI to VIII, on Travelling Carriages (Plate VIII).

B.L. 9.2-inch Howitzers, Marks I and II, on Siege Carriages (Plate VIII).

*For "F.F.-Striker collar"*  
*Read "F.F.-Rebound collar."*

*For "G.G.-Rebound collar"*  
*Read "G.G.-Main spring collar."*

The above-mentioned Plates should also be amended to show the position of reference "G.G." as per sketch below :—



*Issued, January, 1921.*

(B 15335z) Wt. 32214—4845/692 7M 3/21 H & S Ltd. G.H. 66

# HANDBOOK of the B.L. 8-inch Howitzers, Marks VI to VIII.

## PARTICULARS.

|                                     | Mark VI.                                                                        | Mark VII.                                                                       | Marks VII* & VII**.                                                             | Mark VIII.                                                                      |
|-------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| Material                            | Steel                                                                           | Steel (wire construction)                                                       | Steel (wire construction)...                                                    | Steel (wire construction).                                                      |
| Weight (including breech mechanism) | Tons cwts. qrs.                                                                 | Tons cwts. qrs.                                                                 | Tons cwts. qrs.                                                                 | Tons cwts. qrs.                                                                 |
| " (without breech mechanism)        | 2 18 2                                                                          | 3 7 2                                                                           | 3 7 2                                                                           | 3 9 0                                                                           |
| Length, total                       | 2 14 2                                                                          | 3 3 3                                                                           | 3 3 3                                                                           | 3 5 1                                                                           |
| Bore {                              | 127.6-inches                                                                    | 148.3-inches                                                                    | 148.3-inches                                                                    | 148.3-inches.                                                                   |
| Calibre                             | 8-inches                                                                        | 8-inches                                                                        | 8-inches                                                                        | 8-inches.                                                                       |
| Length                              | 117.7-inches                                                                    | 138.4-inches                                                                    | 138.4-inches                                                                    | 138.4-inches.                                                                   |
| Capacity                            | 6,130-cubic inches                                                              | 7,500-cubic inches                                                              | 7,315-cubic inches                                                              | 7,315-cubic inches.                                                             |
| Diameter                            | 8.5-inches...                                                                   | Largest 9-inches, smallest 8.5-inches.                                          | 8.5-inches...                                                                   | 8.5-inches.                                                                     |
| Chamber {                           | 12.74-inches                                                                    | 32.14-inches                                                                    | 35.68-inches                                                                    | 35.68-inches.                                                                   |
| Length                              | 750-cubic inches                                                                | 2,050-cubic inches                                                              | 2,050-cubic inches                                                              | 2,050-cubic inches.                                                             |
| Capacity                            | Polygroove, plain section                                                       | Polygroove, plain section                                                       | Polygroove, plain section                                                       | Polygroove, plain section.                                                      |
| System                              | 102.11-inches                                                                   | 103.06-inches                                                                   | 99.52-inches                                                                    | 99.52-inches.                                                                   |
| Length                              | Uniform, 1 turn in 15                                                           | Uniform, 1 turn in 25                                                           | Uniform, 1 turn in 25                                                           | Uniform, 1 turn in 25                                                           |
| Twist                               | calibres.                                                                       | calibres.                                                                       | calibres.                                                                       | calibres.                                                                       |
| Rifling                             | 48 ...                                                                          | 48 ...                                                                          | 48 ...                                                                          | 48.                                                                             |
| Grooves {                           | .349-inch                                                                       | .349-inch                                                                       | .349-inch                                                                       | .349-inch.                                                                      |
| Number                              | .06-inch                                                                        | .06-inch                                                                        | .06-inch                                                                        | .06-inch.                                                                       |
| Width                               | Pad                                                                             | Pad                                                                             | Pad                                                                             | Pad.                                                                            |
| Depth                               | Axial                                                                           | Axial                                                                           | Axial                                                                           | Axial.                                                                          |
| Obturation                          | Martini-Metford, percussion lock or lock percussion, "P.H." and box slide, "V." | Martini-Metford, percussion lock or lock percussion, "P.H." and box slide, "V." | Martini-Metford, percussion lock or lock percussion, "P.H." and box slide, "V." | Martini-Metford, percussion lock or lock percussion, "P.H." and box slide, "V." |
| Venting                             |                                                                                 |                                                                                 |                                                                                 |                                                                                 |
| Firing, mechanism                   |                                                                                 |                                                                                 |                                                                                 |                                                                                 |

## HOWITZER BODIES.

## HOWITZER BODY, MARK VI.

*(Plate I.)*

The howitzer body is of steel and consists of an "A" tube, jacket, breech bush, rear guide ring, breech ring, front guide ring with stop plate, recoil indicator and side cover plates. The "A" tube extends from the seat of the obturator to the muzzle. The jacket is shrunk over the "A" tube and is secured longitudinally by means of corresponding shoulders on the "A" tube and jacket, also by the breech bush, which is screwed into the rear end; the breech bush is also prepared for the reception of the breech screw. Over a portion of the jacket towards the rear and extending over the chamber and a portion of the bore, is shrunk the rear guide ring, which is furnished on the under-side with two projections with bronze liners, which serve as guides for the howitzer when in the cradle. The breech ring is shrunk over the rear end of the jacket and rear guide ring and screwed to the former. The front guide ring, which is furnished with lugs and bronze liners fitting the guideways on top of the cradle of the carriage, is shrunk† over the jacket along the chase; a bracket is secured on the left side and carries a spring pointer, which serves as a reader for the recoil scale on the cradle. A steel stop plate is attached by four screwed rivets to the front face of the lugs.

The breech ring is prepared for the reception of the breech mechanism and provided on the underside with a lug for attachment to the body of the hydraulic buffer and recuperator of the carriage. Securing screws are provided in the breech face to prevent the breech ring from turning when in position.

The howitzer is provided with "Left" and "Right" gunmetal side cover plates, which are secured by screws to the front guide ring, and are supported at the rear by studs in the rear guides.

For lubricating the cradle slides of the carriage during firing the side cover plates are furnished with upper and lower felt pads, which are held in position by means of retaining plates with fixing screws and locking plates, while, to hold the lubricant, the plates are each arranged with a recess, which is provided with a filling plug attached by a chain.

The chamber is cylindrical, coned at the entrance and reduced in diameter at the front end.

A plane for clinometer is prepared on the right upper side of the breech ring.

Axis lines are cut on the upper side and on the horizontal axis at the breech and muzzle ends. Fine horizontal and vertical axis lines are also cut on the breech and muzzle faces.

The actual weight of the howitzer (without breech mechanism) is engraved on the top of the breech ring, and a line, denoting centre of gravity (without mechanism), is cut transversely on the upper side of the jacket immediately in front of the rear guide ring.

---

† In future manufacture the front guide ring will be *screwed* over the jacket.

The nature, mark, register number, manufacturer's initials and year of manufacture are engraved on the upper portion of the breech face.

#### HOWITZER BODY, MARK VII.

(Plate II.)

The howitzer body is of steel and consists of tubes, a series of layers of steel wire, jacket, breech bush and breech ring. The "A" tube is lined with an inner "A" tube extending from the seat of the obturator to the muzzle, which is secured longitudinally by corresponding shoulders over the seat of obturator and by being slightly conical from front of shoulder to muzzle, and further, by the breech bush. The interior of the "A" tube is also prepared with longitudinal grooves to prevent any turning movement of the inner "A" tube. Around the "A" tube, extending over the chamber and a portion of the bore, are wound successive layers of steel wire. The jacket is fitted and shrunk around the exterior of the wire and a portion of the "A" tube, the whole being secured longitudinally by means of corresponding shoulders on the "A" tube and jacket, also by the breech bush, which is screwed into the jacket at the rear; the bush is also prepared for the reception of the breech screw. The breech ring, which is screwed and shrunk over the rear end of the jacket, is prepared for the reception of the breech mechanism and provided on the underside with a lug for attachment to the body of the hydraulic buffer and recuperator of the carriage. Securing screws are provided in the breech face to prevent the breech ring from turning when in position.

Projections formed on the underside of the jacket at the front and rear, and provided with gunmetal bearing strips with rivets, serve as guides for the howitzer when in the cradle of the carriage. A steel stop plate is attached by four screwed rivets to the front face of the front projections. "Left" and "Right" side cover plates with pads, generally similar to those described for the *Mark VI* howitzer (page 6) are provided on the howitzer for lubricating the cradle slides during firing.

The central portion of the chamber is cylindrical, reduced in diameter at the front and rear.

A plane for clinometer is prepared on the right upper side of the breech ring.

Axis lines are cut on the upper side and on the horizontal axis at the breech and muzzle ends. Fine horizontal and vertical lines are also cut on the breech and muzzle faces.

The actual weight of the howitzer (without breech mechanism) is engraved on the top of the breech ring and a line, denoting centre of gravity (without mechanism) is cut transversely on the upper side of the jacket. The nature, mark, register number, manufacturer's initials and year of manufacture are engraved on the upper portion of the breech face.

## HOWITZER BODY, MARK VII\*.

(Plate III.)

The *Mark VII\** howitzer differs from *Mark VII* in having the chamber made longer and of smaller diameter, the walls of the inner "A" tube being strengthened by being correspondingly thicker over the chamber.

The chamber is cylindrical, reduced in diameter at the front end.

## HOWITZER BODY, MARK VII\*\*.

(Plate III.)

The *Mark VII\*\** howitzer differs from *Mark VII\** in having a shoulder formed on the exterior of the inner "A" tube, so as to strengthen the latter immediately in front of the chamber.

## HOWITZER BODY, MARK VIII.

(Plate III.)

The *Mark VIII* howitzer differs from *Mark VII\*\** in having a thicker "A" tube and in the front end of the jacket being larger in diameter.

## BREECH MECHANISM.

(Plates IV to VI.)

The breech mechanism is worked by means of a lever on the right side of the breech. On pulling the lever to the rear the breech screw is automatically unlocked and swung into the loading position. Conversely, one thrust on the same lever inserts the breech screw and turns it into the locked position.

## BREECH CLOSING MECHANISM.

The breech is closed by a parallel screw of the Welin type, which is divided circumferentially into 12 equal parts, four of which are plain and eight screw-threaded, thus giving a two-thirds bearing surface to the breech screw in the locked position. The screwed parts are of two diameters, the breech opening of the howitzer being prepared in a corresponding manner. The interruptions, or plain portions, in the howitzer are arranged to accommodate the screw-threaded segments having the larger diameter, which, when the screw is unlocked, pass into the interruptions and allow the segments smaller in diameter to unlock into the spaces thereby left vacant by those of the larger diameter.

The interior of the screw is recessed to fit over a pintle on the front of the carrier and is bored through its centre for the reception of the axial vent.

The breech screw is supported when withdrawn by a bronze carrier hinged to the right side of the breech ring, the dead weight of the mechanism being taken on a bronze washer between the carrier and the

bottom lug on the breech ring. Upon the front of the carrier is a pintle forming a pivot for the breech screw which is secured thereon by means of a retaining plate and an eccentric actuating pin in the rear end of the breech screw, so arranged as to admit of the breech screw being revolved through one-twelfth of a circle on the pintle in locking and unlocking.

By pressing the eccentric pin against a spring and partially revolving it until the plate is drawn back flush with the hole in the breech screw, the breech screw can be rotated through  $180^\circ$ , for assembling or dismantling. This arrangement also permits of the carrier being withdrawn independently of the breech screw, should the latter become fast in the breech.

A recess for a crosshead is provided in the right side of the breech screw. The crosshead is actuated by means of a crank and the breech mechanism lever in the carrier so as to revolve the screw in locking and unlocking. A roller, with axis pin, on the rear face of the breech screw and a cam on the breech end are provided to give a turning movement to the breech screw in closing.

A control arc is provided in the hinge joint of the breech ring, over which the lower end of the breech mechanism lever rides, and thus prevents the breech screw rotating as the mechanism is swung into the loading position. The arc also serves as a friction brake, when opening the breech while at angles of elevation, by slightly raising the lever, thus controlling the swing out of the breech mechanism; it has a recess into which the lower end of the lever falls when it is slightly raised and thus retains the mechanism in the open position.

The breech mechanism lever is retained in the closed position by means of a catch in the lever, which engages a steel catch plate in the carrier.

#### FIRING MECHANISM.

The firing mechanisms for use in these howitzers are designed for percussion firing, and are as follows:—(1) A converted Martini-Metford lock, and (2) a percussion lock "P.H." with box slide "V."

##### (1) *Martini-Metford Percussion Lock Mechanism.* (Plates IV to VI.)

A steel vent bolt passes through the centre of the breech screw and the pintle on the carrier, being feathered to the latter to prevent it turning, and is retained in the breech screw by means of a spiral spring and nut. Through the longitudinal axis of the vent bolt is fitted a vent bush spindle prepared with a firing channel and chambered at the rear end to suit the "Tube, percussion, S.A. cartridge." The vent bush spindle is furnished at the rear end with a converted Martini-Metford percussion lock, which is screwed to the vent bush spindle and is prevented from turning by a securing block and keep pin. It is secured in the axial vent bolt by a nut and copper washer at the front end.

A bronze safety shutter, actuated by the breech screw in locking and unlocking, is provided in the exterior of the carrier and serves to prevent the insertion of the firing peg into the lock until the breech screw is locked in the howitzer.



A retaining pin with keep pin is provided in the left side of the carrier for retaining the vent axial nut and safety shutter in position.

The No. 35, firing lanyard, which is attached to the loop of the firing peg, is pulled from the right side, for which purpose a fairlead stud is provided on the outer end of the screw securing the breech mechanism lever bearing on the right rear face of the carrier.

*Method of Using M.M. Converted Lock.*

The "Tube, percussion, S.A. cartridge" will always be inserted into the tube chamber after the breech of the howitzer is closed and the breech mechanism lever home. After inserting the tube into the tube chamber the firing peg will be placed in the hole in the lock for its reception from the right side and pushed home. The breech of the lock will then be closed by pushing the actuating lever of the lock to the front. The howitzer can then be fired by pulling out the firing peg.

The firing peg must always be inserted in the lock before closing the breech of the lock and care must be taken to see that the peg is in position when the actuating lever is pushed forward in closing.

(2) *Lock Percussion, "P.H." and Box Slide "V."*

(Plates VII and VIII.)

The firing mechanism with percussion lock "P.H." and "V" slide box, consists of an axial vent originally provided with a vent bush spindle which is generally similar to but not interchangeable with, the vent bush spindle used with the Martini-Metford percussion lock, the outer end of the axial vent being chambered to suit the tube and prepared on the exterior with a screw thread for the reception of the "V" slide box.

The box, slide, "V" consists of a steel body screwed internally to suit the outer end of the axial vent and prepared for the reception of the percussion lock "P.H." In the interior of the slide box is pivoted an extractor lever, the inner end of which engages the percussion tube in the vent, and has on the outer end a lug, by means of which it is actuated in working the lock. Secured on the exterior by two screwed rivets is a steel stop plate for the actuating lever catch of the lock, and when in position the slide box is prevented from turning by a securing screw.

The percussion lock "P.H." consists of a steel frame with firing hole bush, and furnished with a striker, striker nut and cap, main spring and rebound collars, and main spring. The lock slides vertically in the slide box and is worked by means of an actuating lever with retaining catch plunger and spring, pivoted on the exterior of the frame. The striker is withdrawn and the main spring compressed by a steel wedge shaped fork on the No. 33 firing lanyard, which engages the striker cap when placed in position, and is released in firing by pulling the lanyard clear of the lock.

## OBTURATION.

(Plates IV and VI.)

The obturator, which is of the steep-coned type, is supported on the axial vent and is held tightly between the mushroom-shaped head of the latter and the front face of the breech screw by the spring and nut, vent axial.

The pad consists of asbestos worked up in mutton suet or rape oil to a proper consistency, enclosed in a strong canvas cover in the case of *Mark I* and wire woven cover in the case of *Mark II*, and pressed into shape in a hydraulic machine.

The pad is enclosed between a front copper protecting disc, around the outer edge of which is a split steel ring, and rear inner and outer steel rings, the outer one being split. The disc is stamped with the word "front" and the pad has the word "front" stencilled on the side which corresponds with the front disc and "rear" on that which corresponds with the inner and outer rear rings, in order that they may be correctly assembled on the vent.

If correctly assembled the whole should fit together compactly.

Thin steel adjusting discs are provided for insertion behind the rear steel rings and pad when found necessary.

*Action.*—When the breech screw is swung into the breech opening, the obturator enters the chamber with ease; on turning the breech screw the pad is pressed home into the coned seating of the chamber by the travel of the screw. The bore is thus closed by the pad which is in contact with the bore all round its circumference, while the mushroom head of the axial vent receives the force of the gas on discharge. On firing the howitzer, the pressure acts on the mushroom head of the vent and compresses the pad against the breech screw, thus causing it to expand. This expansion is radial to the axis and equal in every direction and is sufficient to prevent the escape of gas. On the pressure being removed elasticity comes into play and the obturator can be withdrawn from the coned seating so soon as the screw is unlocked.

For instructions regarding the fitting, testing, adjusting and treatment of obturating pads and discs, see "*Regulations for Magazines and Care of War Matériel*," and page 44.

## TO REMOVE THE BREECH FITTINGS.

Before removing the breech fittings the breech mechanism must be swung into the loading position.

*Arc, control and cam rotating breech.*—Remove the fixing screws and withdraw the control arc or rotating cam respectively. (These fittings should not be taken off more often than is necessary.)

*"P.H." percussion lock.*—Remove the extractor axis screw from the "Box, slide, V" and turn the actuating lever of the lock to the open position, then withdraw the lock and extractor lever from the slide box in a downward direction.

*Box, slide, "V."*—Remove the securing screw and unscrew the slide box from the axial vent and withdraw to the rear.

*Vent axial, safety shutter and obturator.*—Remove the keep pin from the “pin, retaining axial vent nut and safety shutter,” and withdraw the latter clear of the recesses in the vent axial nut and safety shutter. Unscrew the vent axial nut and remove the nut and safety shutter to the rear. Withdraw the axial vent and obturator from the front end of the breech screw.

*Breech screw.*—Insert a screwdriver in slot of the eccentric “pin, actuating retaining plate,” press in the pin and partially revolve it by means of the screwdriver until the indicating arrow on the pin corresponds with the middle of the word “dismantle” on the breech screw, then withdraw the breech screw from the front of the carrier.

*Roller, breech screw.*—Remove the keep pin and roller axis pin, and withdraw the roller.

*Breech mechanism lever.*—Remove the keep pin and nut from the crank shaft, and withdraw the breech mechanism lever.

*Breech mechanism lever bearing, crank shaft and crosshead.*—Remove the keep pin of the screw securing breech mechanism lever bearing and withdraw the securing screw. Withdraw the bearing and crank shaft from the carrier; at the same time, from inside the carrier, remove the crosshead from the inner end of the crank shaft.

*Catch, breech mechanism lever.*—Drive out the securing pin of the spring retaining block, slide the catch downwards in the breech mechanism lever and withdraw the catch, then remove the spring and retaining block.

*Carrier.*—Remove the keep pin from the carrier hinge pin and withdraw the latter, then remove the carrier and bearing washer.

The undermentioned fittings are not intended to be removed except on account of repair, as securing screws or stop rivets would have to be drilled or cut out to effect their removal:—

*Pin, retaining, axial vent nut and safety shutter.*

*Plate, catch, breech mechanism lever.*

*Plate, retaining, breech screw.*

#### TO ASSEMBLE THE BREECH FITTINGS.

The converse of the above takes place in re-assembling the fittings on the howitzer.

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## PART II.

**CARRIAGES, TRAVELLING, B.L. 8-IN.  
HOWITZER, Marks VI to VIIa.**

**CARRIAGE, MARK VI.**

(*Plates IX and X.*)

The carriage is designed to admit of the howitzer being fired up to 50° elevation.

The howitzer is mounted on a cradle along which it is free to recoil under the control of a hydraulic buffer and is returned to the firing position after recoil by means of a hydro-pneumatic recuperator. A cut-off gear is fitted to the cradle and buffer, in such a manner, that, as the elevation increases, the length of recoil is proportionately decreased, in order to prevent the howitzer striking the trail or ground. A quick loading gear and depression stop are fitted to the cradle for bringing the howitzer rapidly from the firing to the loading angle (7° 30' elevation) and *vice versa*, the gear being so arranged that when it is worked the sight line is not interfered with.

The cradle is pivoted by trunnions to a saddle and between the latter and the cradle is interposed the elevating gear.

The saddle is pivoted at its centre, in front, to a transom on the trail, in such a manner that its rear end is free to slide, under the control of a traversing gear, to the extent of 4° right and 4° left, an indicator being fitted to show the amount of traverse in either direction.

The trail is of the bracket type and is supported on a cranked axletree which is fitted with tractor wheels. The rear end of the trail, underneath, is fitted with a spade to anchor the trail when in the firing position and screw brakes are fitted to either side which are for use in firing and travelling.

*When using the firing platform* the spade is removed from the rear end of the trail and in its place is bolted a sole plate provided with a curved rib or thrust bracket projecting downwards into a channel in the rear beam. This takes the thrust of recoil and also guides the trail end when traversing from one position to another. The rear end of the trail being held in position laterally by a pin passing through the sole plate into holes in the rear beam.

*When the firing platform is not used* the spade can be bolted on in place of the sole plate, or alternatively a recoil shoe may be substituted for use in conjunction with the wedge scotches for the wheels.

The sights, which are of the reciprocating type, are carried on a bracket, pivoted to the left rear of the saddle. They are connected through a "Sight operating gear" to the elevating arc so that the movement of the latter is transmitted to the sight when the elevating gear is worked.

A cradle clamp with pawl, is fitted to the trail to lock the trail and cradle together when travelling to prevent any strain coming on the elevating, traversing and quick-loading gears, and a loading bogie fitted with a carrier and loading tray is provided which can be mounted on rails on top of the trail.

The principal parts of the carriage are :—

- Trail.
- Axletree and wheels.
- Brake gear.
- Saddle.
- Traversing gear and traversing indicator.
- Cradle with quick loading gear.
- Cradle clamp.
- Hydraulic buffer with cut-off gear.
- Hydro-pneumatic recuperator.
- Elevating gear.
- Loading bogie, etc.

#### TRAIL.

The trail consists of two steel side brackets joined at their front ends by a transom and at the rear by a top and bottom plate. The top plate has three oak slats fixed across it to prevent the loading numbers slipping. The transom is pierced vertically to receive the pivot pin of the saddle. Each side bracket carries a M.B. clip on top about its centre on which a clip on the rear end of each saddle bracket slides. The top front end of each bracket is fitted with a facing strip on which the saddle rests and clips are also fitted at this point to engage with clips on the saddle to prevent the latter lifting on firing. A bracket is riveted to either side bracket, underneath, in which bearings are formed for the axletree. Each side bracket also carries brackets for the attachment of the cradle clamp or rails for the loading bogie. Clips to hold the portable air compressor in position whilst charging the recuperator are riveted to the top plate near the lower end; the two rear clips are also used for securing the bar supporting the rear ends of rails for loading bogie. The lower end of the trail is fitted with locking plates, spade, trail eye, lifting handles and sockets to take handspikes for lifting purposes. For the purpose of taking the wear off the trail eye it is fitted with a preserving clip. When the carriage is used with the firing platform the spade is replaced by a sole plate, which is provided with a thrust bracket and is bolted to the underside of the trail. To prevent the thrust bracket coming out of the channel guide of the platform when firing, a holding-down clip and bracket is secured at each side of the trail. A recoil shoe, which can be bolted to the underside of the trail, is provided to protect the thrust bracket and provide a flat support for the rear end of the trail when not using the platform, wedge scotches being used with the wheels when firing. Fittings are provided on the trail for housing a combined brush, rammer and sponge, cleaner, piasaba, end and intermediate staves, handspikes, loading tray and cradle clamp when

not in use; also leather cases to carry a sight clinometer and two rimers and a wood block for housing an oil can. Clips for carrying the case, memo. of examination, are fitted to the left side of the trail.

A draught link is riveted to the centre of the front transom; the front end of the link is forked and is provided with a pin and key for connecting up another limber, when travelling in series, or the carrier transporting firing platform.

#### AXLETREE AND WHEELS.

*Axletree, special, No. 28.*—The body of the axletree is generally circular in shape and fits in the bearings on the underside of the trail. To either end is shrunk on a bracket through which it is bolted to the trail. The brackets have cranked extensions which form axletree arms. The outer end of each arm is prepared to take a cap and pin to hold the wheel in position.

The *Mark II* axletree differs from the *Mark I* described above, principally in having the arms formed in one with the body and further, in the case of axletrees of later manufacture, in having solid instead of hollow arms, in consequence of which the cap is replaced by a securing collar.

*Wheels.*—Tractor wheels, special, No. 88, "Right" and "Left" are supplied with this equipment. They are of steel 5-feet 6-inches in diameter with a sole 12-inches wide and are fitted with a Stauffer's lubricator, No. 7. Diagonal ribs are riveted across the sole to give a better grip on bad ground. A steel brake ring is secured to the inner circumference of each wheel.

The wheels are held on the axle arms by a drag washer, cap or collar and a pin, which, passing through the cap or collar and axle arm, is held underneath by a split pin.

The wheels being "Right" or "Left" are not interchangeable from one side to the other.

#### BRAKE GEAR.

(Plate XII.)

Screw brakes for use in firing and travelling are fitted, one to each side of the carriage, each side acting independently.

Bolted to the axletree bracket is a supporting bracket, the upper end of which is forked and carries a rocking pin, while its lower end has pivoted to it a steel arm forming a brake hanger. The upper end of the hanger carries a steel nut through which works a screw, which also passes through the centre of the rocking pin in which it is held by a shoulder in front and disc springs, No. 83, with nut and pin, in rear; a handwheel is nudded to the front end of the screw. The lower end of the hanger has attached to it a clip, or brake shoe, in which is secured a wood block to act against the brake ring on the wheel. Consequently, when the screw is turned, the nut, with upper end of hanger, travels along the screw, revolving the lower end of the hanger in an opposite direction and thus brings the block to bear against the wheel, or revolves it clear as the case may be; the rocking pin revolving in its bearing allows the screw and nut the necessary movement to conform to the arc of a circle described by the hanger.



## SADDLE.

The saddle is pivoted at its front end to the trail in such a manner that its rear end can be moved by means of the traversing gear 4° Right and 4° Left across the top of the trail, so that small changes in direction can be given without disturbing the spade.

It consists of two steel side pieces joined at their front ends by a transom, which has an opening in its centre, to receive a pivot pin which passes through a bracket in the trail and is held underneath by a nut and pin. The opening is provided with a dust cover to prevent the ingress of dirt and dust.

Brackets are riveted to each side piece in which are formed bearings for the cradle trunnions, hinged capsquares being provided to keep the latter in position. A bracket, having an opening to receive the spring plunger of the quick loading gear when the howitzer is in the loading position, is fitted to the front of the transom on the right side and to the left side towards the rear is riveted a guide for the elevating arc to work in. Holding down clips are bolted to either side piece, front and rear, to engage clips on the trail which hold the saddle down on firing, and a bracket to support the elevating and traversing gears and sight is riveted to the rear of the left side piece. There is also a bracket on the right side piece, in which is secured a pillar to carry a No. 1 dial sight.

A leather case is attached to the right side in which is carried the No. 1 dial sight.

## TRAVERSING GEAR.

(Plate XXII.)

The traversing gear is interposed between the trail and the rear end of the saddle on the left side. It consists of a M.B. pivot which is supported in a bracket on the trail. Held in the pivot is a traversing screw, the right end of which works in the left end of a nut which is hinged at its right end to an arm on the bracket of the elevating gear on the saddle. A steel cover, screwed and pinned to the pivot, envelops the screw and nut to prevent the ingress of dirt and dust. The cover has engraved on its upper side a zero mark, which is read by a pointer attached to the longitudinal spindle bearing of the elevating gear bracket on the saddle. Near the left end of the screw a flange is formed and between this and the bearing in the pivot are placed Hoffmann ball bearings. The outer face of the pivot forms a gear casing in which and feathered to the traversing screw is a spur wheel, between the boss of which and the gear casing is another set of Hoffmann ball bearings. Gearing into the spur wheel is a spur pinion on a short spindle, supported in bearings in the gear case cover of the bracket on the trail, which has on its outer end a hand-wheel for working the gear. The spur gear is closed in by a cover which is bolted to the casing.



The angle of traverse is indicated by a pointer on the elevating gear bracket on the saddle, reading a scale plate graduated up to  $4^{\circ}$  Right and Left, which is attached to the bracket on the trail. The bracket is also fitted with two traversing stops. One revolution of the hand-wheel equals 10 mins. traverse.

**NOTE.**—The traversing gear must be placed at zero before connecting the cradle clamp to the cradle.

#### CRADLE.

(Plate XIV and XIV A.)

The cradle is U-shaped, and is provided about its centre with trunnions to fit the trunnion bearings on the saddle, in which they are held by hinged capsquares secured by pins. Roller bearings surround the cradle trunnions to reduce the friction in elevating and depressing the howitzer. Caps, with flanges to fit outside the bearings on the saddle, are screwed into the trunnions and are retained by set screws. A top plate fitted to the cradle has top guideways to take the guides on the howitzer and under guideways to take the guides on the body of the hydraulic buffer and recuperator. The front end of the cradle is closed by a cap to which are attached the piston rod of the hydraulic buffer and rams of the recuperator. The cap is fitted with a door which enables the recuperator to be charged with air or the air pressure to be tested without removing the cradle cap (*see* Plate XVIII). Brackets are fitted on the right side of the cradle, which form bearings for the quick-loading and cut-off gears, and on the underside at the front to support a depression stop. Leather pads, enclosed by a brass casing, are fitted to the top front of the cradle to act as a stop to the howitzer in running up. The cradle projects some distance beyond the breech of the howitzer to form a support for the latter in the recoiled position; the projection is prepared on the underside to receive the cradle clamp securing pins and on top to receive the loading tray.

A spring pointer, which is held in a bracket secured to the front guide ring of the howitzer on the left side, in conjunction with the scale of degrees on the cradle, indicates the correct amount of recoil according to the elevation at which the howitzer is fired.

A lifting handle is fitted on the left side at the rear and a lowering bar is secured in two brackets riveted to the underside of the cradle at the front.

#### QUICK LOADING GEAR.

(Plate XIII.)

This gear is provided to unlock the cradle from the elevating arc and thus allow the howitzer to be brought rapidly from the firing to the loading angle ( $7^{\circ} 30'$  elevation) and *vice versa*.

The gear consists of a cross spindle supported in bearings on the underside of the cradle, to the right end of which is pinned the front end of an actuating lever, which is supported in a bracket on the right side of the cradle. The actuating lever has at its front end a

cranked extension, to which is pinned the rear end of a connecting rod. The latter, at its front end, has pinned to it a spring plunger, which engages in a recess in a bracket on the breast of the saddle when the howitzer is in the loading position, and so holds the cradle and howitzer steady for loading. The plunger is supported in a bearing, which is pivoted in a bracket on the right front of the cradle. To the left end of the cross spindle is nipped the lower end of a short lever, to the upper end of which is pinned a spring plunger, which is held in a bracket on the left rear of the cradle and which engages in a recess in the elevating arc when the howitzer is in the firing position and so locks the cradle to the latter.

*Action.*—The howitzer having fired, the actuating lever is raised. This revolves the cross spindle and lever on the left, thus withdrawing the plunger from the elevating arc, compressing the spring and unlocking the cradle. The actuating lever then comes to the end of its slot and continuing to lift on it depresses the howitzer to the loading position at which point the right plunger is forced into its recess in the bracket on the saddle by the action of its spring. A stop (see Fig. 9, page 50) is provided to bring the howitzer to rest at the proper loading angle. It consists of a block of wood bolted in brackets on the underside of the cradle, which, when the howitzer is depressed after firing, fouls the transom of the saddle. If it is required to depress below the loading angle the block must be removed. Before working the quick-loading gear the stop must be in position, or damage will be done to the gear. After loading, the actuating lever is pressed downwards, which withdraws the plunger on the right, elevates the cradle and howitzer until the left plunger, which slides along the elevating arc, comes opposite its recess in the latter, into which it engages under the action of its spring, thereby locking arc and cradle together and the latter can then only be moved by working the elevating gear.

**NOTE.**—The quick-loading gear must be disengaged for travelling by withdrawing the locking plunger from the elevating arc, the handle of the actuating lever being supported by the pawl of the cradle clamp.

#### CRADLE CLAMP.

(Plate IX.)

The cradle clamp consists of a channel steel bar, the right end of which is pivoted to a bracket on top of the right side bracket of the trail by a bayonet joint and can be attached or detached when it is swung out to an angle of 45 degrees from the right side bracket.

The other end of the bar is shaped to fit into a bracket on the left side bracket of the trail, to which it is secured by a locking pin, which, when not in use, is suspended on the side of the bar by a spring clip and hook.

On top of the bar are two brackets formed with double lugs, through which it is pinned to the cradle for travelling purposes.

In order to prevent the plunger hole in the elevating arc from being distorted when travelling, a steel pawl will, in future manufacture, or when returned for repair, be fitted to the cradle clamp to support the hand lever of the quick-loading gear and thus hold the plunger in the disengaged position.

The rear end of the pawl is formed to fit on top of the channel bar outside the right bracket and is provided with a pin on its inner side by which the pawl is pivoted in the bracket. (When the pawl is in use this pin replaces one of those formerly used for securing the cradle to the clamp when travelling.) On the outside is formed a projection which engages a slot cut in the bracket and is prepared to take a spring keep pin for securing the pawl when in position.

The front end of the pawl is provided with a projecting flat on its upper edge, which supports the hand lever of the quick-loading gear when travelling.

#### HYDRAULIC BUFFER, &C.

(Plate XIV.)

The buffer and recuperator cylinders are contained in a steel cylinder block forming a body which fits inside the cradle, and is provided with a guide on each side to fit in the guideways on the underside of the top plate of the latter. The body is secured at its rear end to the lug of the howitzer and thus recoils with it, while the piston rod of the buffer and rams of recuperator being nutted up to the cradle cap, remain stationary. Five parallel openings are bored through the body, viz., a centre one to form the buffer cylinder, two outside lower ones forming the recuperator liquid cylinders and the two upper ones forming the recuperator H.P. cylinders.

*Hydraulic buffer.*—The buffer cylinder has two spiral grooves cut in its interior surface to rotate the rotating valve during recoil and run-up. The front end is closed by a steel stuffing-box, which is screwed into it against a steel joint ring and fibre washer to make a tight joint. The stuffing-box contains an L-leather or rubber,† which is held in position by a hollow gland, in which is placed a compressed packing ring, supported in front by a sleeve against the flange of which bears a spiral spring, the whole being kept in position by a cap which screws on to the stuffing-box and bears against the front end of the spring. The glands are provided with two holes,  $\frac{1}{4}$ -inch in diameter, to facilitate their removal without damaging the packings, while the cap is provided with three holes to relieve pressure that may accumulate between the sleeve and the inner wall of the stuffing-box. The stuffing-box and cap are kept from unscrewing by locking plates.

The rear end is closed by a steel plug forming a buffer extension, which is screwed in against a leather washer to make a tight joint

† When L-rubbers are fitted, a plate notifying the same is attached to the front end of the cylinder block.

and is kept from unscrewing by a locking plate. The plug is screwed externally to receive a nut by means of which the buffer, &c., is connected to the lug on the breech ring of the howitzer and internally it is bored out to form a control cylinder, which is fitted at the entrance with a M.B. bush. A small passage is bored through the plug, which places the control cylinder into communication with the buffer cylinder. This passage is closed by the stem of a plug-adjusting run-out, on which are formed flats, by means of which the rate of run-up of the howitzer is regulated (*see* Plate XVI).

The piston rod and piston are of steel, in one forging with the control plunger. The rod passes out through the stuffing-box at the front end and is nutted up to the front cap of the cradle. Inside the cap the piston rod has feathered to it a toothed bevel segment, which forms part of the cut-off gear.

The rod is hollow and the front end is screwed to take an "adapter, oil filling," to which the pipe from the "pump, liquid, portable," is connected when filling. A small side hole at the rear connects the interior of the rod with the buffer cylinder. When the adapter is not in use the opening at the front is closed by a screwed plug.

The piston has two plain ports for the passage of liquid from one side to the other on recoil and run-up, and an H.R. M.B. ring around its periphery to prevent scoring the cylinder.

The control plunger projects to the rear of the piston and has a flat cut on it for the greater part of its length. The remaining portion is cylindrical and is a good fit inside the control plunger cylinder. The base of the plunger is prepared for the reception of the rotating valve and its fittings.

The rotating valve is of metal and is placed in rear of the piston over the control plunger, around which it is free to revolve. It has two shaped ports formed in it for the passage of liquid and two studs or feathers on its periphery to work in the spiral grooves of the buffer cylinder, which serve to operate the valve during recoil and run-out. The valve is held against the rear face of the piston by a steel thrust ring, which is feathered to the control plunger and, in turn, is held by a securing nut and pin.

The front end of the buffer is provided with two holes, one of which (that on the right) serves as an air hole and is closed by a screwed plug with leather washer. The left hole is fitted with a snifting valve (Plate XVII), which is actuated by a spindle, which passes out through the cradle cap and is fitted with a knob. This arrangement permits of any air which may have accumulated in the buffer cylinder being released without removing the cradle cap.

#### TANKS, GRAVITY.

(Plate XIX.)

The *Mark I* tank is of manganese bronze and holds 8 pints of liquid. It is bolted to the front guide of the howitzer on the right side, and serves to automatically replace any loss of liquid from the buffer

cylinder. The tank is provided at the top with a filling-hole fitted with a brass gauze strainer and closed by a screwed plug with a washer of "Navy" red material (compressed asbestos fibre composition); a small relief valve is nutted to the bottom of the plug and fits inside the strainer. To prevent a vacuum forming in the tank, six holes are bored vertically through the filling-hole plug and are closed on the underside by a washer of "Navy" red material, which is held in position by the nut securing the relief valve; the nut is rounded to allow of movement of the washer. The top of the tank is closed by a gunmetal cover with a washer of "Navy" red material. To indicate the liquid level, a sight glass, with reflector, is fitted to the bottom of the tank in rear and a copper feed pipe with suitable connections places the tank in communication with the rear end of the buffer cylinder. Should the tank or connecting pipe be damaged so as to render them unserviceable, the elbow connection at rear end of cradle should be removed and replaced by the solid steel "plug, tank inlet," provided.

The *Mark II* tank differs principally from the *Mark I* in having the filling-hole formed in the tank cover instead of in the body of the tank and in the strainer being conical in shape instead of cylindrical.

#### CUT-OFF GEAR.

(Plate XX.)

This gear consists of a steel actuating rod held in bearings on the right side of the cradle; its rear end is forked and pinned to a link which fits around the right trunnion and is supported at its rear end on the capsquare pin, while its front end is attached by a screwed eye and pin to a short vertical lever, which is formed on the outer end of a short cross spindle. The latter passes inside the cradle cap and carries on its inner end a bevel segment which engages with the bevel segment feathered to the piston rod. The screwed end of the eye is slotted to permit of any adjustment which may be required to lengthen or shorten the recoil and is engraved to indicate the direction in which the eye should be turned.

*Action.*—On elevating the howitzer, the actuating rod pulls upon the short lever, thus rotating the cross spindle, bevel segments, piston rod and piston and thereby decreasing the flow space between the ports in the latter and the rotating valve, which is held fast by its feathers and grooves in the cylinder. This increases the resistance set up in the buffer cylinder during recoil, thereby shortening the recoil of the howitzer. The recoil varies from 60-inches, howitzer horizontal, to 24-inches at 50° elevation.

The working recoil at 24° elevation is 42·5-inches giving a clearance of 4·5-inches between the rifle firing mechanism and the trail.

#### RECUPERATOR.

(Plates XIV.)

The recuperator is on the hydro-pneumatic principle and consists of two liquid cylinders in which work rams, and two H.P. cylinders



which contain liquid and compressed air. The front ends of the liquid cylinders and also the rear ends of the H.P. cylinders are connected by equalizing passages; while the latter are also connected to the front of the liquid cylinders by an opening in the cylinder block, through which liquid is forced on recoil and run up.

The liquid cylinders consist principally of steel tubes, which are screwed into the two lower openings in the cylinder block; between the exterior of the tube and the wall of the opening in the block an annular space is formed, surrounding the tube throughout its entire length and filled with liquid when the system is charged. This space is in communication with the rear of the H.P. cylinders by an opening in the cylinder block and with the liquid cylinders by means of holes formed in the tube in front of the throttle valve.

The rear ends are closed by perforated dust caps. Fitted to the centre of each cap is a stud which carries a rubber washer held in position by a brass disc and nut. The perforations allow any liquid which may leak past the piston to get clear, otherwise the howitzer would not return fully to the firing position after recoil. The holes in the cap also prevent a vacuum forming in rear of the recuperator rams.

The front ends are closed by stuffing boxes, packing and caps in the same manner as the buffer cylinder, except that the steel joint ring is omitted. Internally, near its front end, each cylinder is reduced in diameter to form a seating for a throttle valve, which fits loosely around the ram and is kept up to its work by a spiral spring, one end of which bears against the valve and the other end against a manganese bronze centring collar which is fitted on the ram between the stuffing-box and throttle valve in order to keep the valve spring in position.

The valves are each provided with a coned head to fit tightly on their seating. Holes are bored through the head to allow liquid to pass back again into the cylinders after recoil.

The *Mark III* recuperator rams are of steel; their front ends are each secured by a screwed collar inside and a nut outside to the cradle cap. Screwed into the collar and ram is a stud which engages between two pegs screwed into the front cap of the cradle on the inside to prevent the ram moving when the connecting nut is being tightened up or released. Their inner ends are each provided with a packed piston.

The piston packing is divided into two parts, front and rear. The front part consists of two "U" rubbers or leathers, with supporting rings held in position by a collar screwed and pinned to the ram. To prevent an intensified pressure being placed on the rear "U" rubber, a steel stop ring, in halves, is fitted into an annular recess formed in the piston in rear of the rear supporting ring. The rear part consists of a compressed packing ring and supporting ring held in position by a spiral spring compressed by a cap, screwed on to the rear end of the piston head. The cap is kept from unscrewing by a spring plunger contained within the piston head and fitting a squared opening in the cap.

The *Marks I\** and *II\** rams are *Marks I* and *II* rams, respectively, which have been modified to take a detachable head generally similar to the head of the *Mark III* ram.

The rams are hollow; the front end of each is prepared to take an "adapter, oil filling," to which the pipe from the "pump, liquid, portable," is connected when filling. A small side hole at the rear connects the interior of the rams with the liquid cylinders. When the adapter is not in use the opening at the front is closed by a screw plug.

The H.P. cylinders are plain tubes having their front ends closed by steel plugs, which are secured by nuts. Their rear ends, which are screwed into the cylinder block, are connected together by a passage bored through the cylinder block and are also connected to the front of the liquid cylinders from a point in front of the throttle valves, by the annular space which surrounds the liquid cylinders.

The front closing plugs are fitted with air holes at such a level as to ensure the correct charging of the recuperator with liquid, when the howitzer is level both longitudinally and transversely; the front plug of the left cylinder is fitted with a cut-off valve and has also a hole prepared to take an "adapter, pressure gauge," to which is connected the copper pipe leading from the portable air compressor when charging, or the pressure gauge when testing the air pressure (see Plate XVIII). When the adapter is not in use the opening is closed by a screw plug.

#### ACTION OF BUFFER AND RECUPERATOR.

Before firing, the operation of elevating prepares the buffer for the correct length of recoil.

On firing, the buffer and recuperator body, or cylinder block, being attached to the howitzer, recoils with it, while the piston rod of the buffer and rams of the recuperator, being nudded up to the front cradle cap, remain stationary.

As the cylinder block is drawn back the liquid in the buffer cylinder is forced from the front to the rear of the piston through the ports in the piston and rotating valve. At the commencement of the recoil the ports in the piston are more or less uncovered by those in the rotating valve (the amount of opening varies with the elevation), but as the recoil proceeds the rotating valve is forced to revolve on the control plunger by the studs on its periphery, which engage in the grooves in the cylinder and the ports in the piston are thereby gradually closed, thus setting up an increasing resistance in the buffer and so absorbing the energy of recoil of the howitzer.

At the same time the rams of the recuperator force the liquid from the liquid cylinders into the H.P. cylinders, the throttle valves being forced off their seatings for this purpose and the liquid entering into the H.P. cylinders raises the air pressure in the system.

On the recoil ceasing the throttle valves close, the air expands and forces the liquid back into the liquid cylinders through the holes in the throttle valves, thus returning the howitzer into the firing position. The howitzer is prevented from running up with violence by the resistance set up in the hydraulic buffer by the passage of the



liquid from rear to front of piston, by the slowness with which the liquid is forced from the H.P. into the liquid cylinders through the restricted holes in the throttle valves, and also by the control plunger, which latter, as the howitzer nears the firing position, enters its cylinder and forces the liquid therein, first over the tapering flat on the plunger and also past the adjustable valve through the side channel, but finally through the latter means only.

#### ELEVATING GEAR.

(Plate XXII.)

The elevating gear is supported in a bracket attached to the left side of the saddle at the rear. Supported in bearings in this bracket is a longitudinal spindle, which has, at its rear end, a hand-wheel and, at its front end, a bevel pinion. The pinion gears into a bevel wheel on the lower end of an oblique shaft, which carries a worm, which gears into a wormwheel formed on the outer end of a short cross spindle, on the inner end of which is a spur pinion which engages into the elevating arc. The worm shaft is fitted with friction washers at either end of the worm and an adjusting bush with locking plate at its lower end. The wheels and pinions are closed in by a metal cover secured to the bracket by screws. The elevating arc fits loosely around the cradle trunnion on the left side and has a recess to take the firing or left plunger of the quick-loading gear. When this plunger is engaging in its recess, the cradle and arc are locked together and elevation or depression can only be given by working the elevating gear. The arc carries on its upper side at the front end a link for the attachment of one end of the connecting rod of the sight operating gear. It is fitted with a steel emergency clamp, in two parts, and a steel stop, the clamp, which is to enable the cradle to be locked to the arc in the event of the plunger or plunger-bracket becoming broken, being secured to the arc by means of a bolt and nut and the stop by a securing screw.

A scale plate graduated up to  $50^{\circ}$  is attached to the bracket supporting the sight, the graduations being indicated by a pointer attached to a bracket on the saddle. One revolution of the hand-wheels equals 45 minutes elevation or depression, as the case may be.

**NOTE :—**To avoid damage to equipments not having a pawl fitted to the cradle clamp, when travelling over rough roads, the elevating gear should invariably be thrown out of engagement with the cradle when connecting the latter to the 'cradle clamp.' This is done by raising the actuating lever of the 'quick loading gear' and rotating elevating handwheel two or three turns, thus throwing the plunger out of gear with the elevating arc."

#### LOADING BOGIE, CARRIER, TRAY AND RAILS.

(Plate XXIII.)

The *loading bogie* consists principally of a built-up steel body, which is fitted with 4 M.B. wheels, so that it may be mounted on steel rails secured to the top of the trail. It is held to the rails by means

of steel clips and is moved to and from the loading position by a tubular steel porter bar. The bogie is fitted with a stop for the carrier, loading tray and with a traversing scale, which is read by a pointer on the loading tray carrier.

The *carrier, loading tray*, consists principally of two M.B. supports which are provided with steel axles and M.B. wheels and is mounted on transverse rails on top of the bogie, which permit of it being traversed  $4^\circ$  right or left, so that it may be adjusted to suit the angle of traverse of the howitzer. A locking device for securing the carrier in the required angle of traverse is also provided.

The *loading tray* is of steel, trough-shaped and is secured in position on the carrier, loading tray, by means of front and rear clips and a locking pin, the latter being secured to the carrier by a chain and eye.

The steel rails on which the loading bogie is mounted are detachable and are laid longitudinally on top of the trail, being secured thereon by means of hinge pins and brackets. The rails, which are left and right, are each provided with a bogie stop at their rear ends, which are attached to a supporting bar secured to the rear clips for air compressor. In addition, the left rail is fitted at the front end with a pawl which engages a clip on the bogie and serves to retain the bogie in the loading position.

#### CARRIAGE, MARK VII.

(Plate XI and XI A.)

The *Mark VII* carriage, which is for the *Marks VII, VII\** and *VII\*\** howitzers, differs principally from the *Mark VI* in the buffer, cut-off gear and recuperator, which is modified to enable the longer (17.3 calibre) howitzers to be used.

The rear closing plug of the buffer is made longer to permit of the cylinder body being connected to the howitzer lug, to which it is secured by a collar inside the lug in addition to the nut outside, and has a "valve, adjusting, run-out," screwed into one side of the rear closing plug instead of into the rear end, as in the case of the *Mark VI*.

The buffer cylinder is slightly larger in diameter thus placing the centres of the recuperator cylinders farther apart, necessitating a different cradle cap to that of the *Mark VI*.

A steel stop is fitted to the elevating arc by means of two screws to limit the maximum elevation to  $45^\circ$ .

The recoil varies from 52-inches howitzer horizontal to 24-inches at  $45^\circ$  elevation.

The working recoil at  $24^\circ$  elevation is 37.5 inches giving a clearance of 2.8 inches between the rifle firing mechanism and the trail.

#### CARRIAGE, MARK VIIA.

(Plate XI and XI A.)

The *Mark VIIA* carriage is generally similar to the *Mark VII*, from which it differs in being designed to take the *Mark VIII* howitzers, consequent on which the "collar, connecting, ram" is of a longer pattern and the "band, securing cap," is further cut away to accommodate the howitzer.

DIMENSIONS, WEIGHTS, &c.

|                                                                                  | Mark VI Howitzer<br>on<br>Mark VI Carriage. | Marks VII*, VII**<br>Howitzer on Mark VII<br>Carriage. | Mark VIII Howitzer<br>on<br>Mark VIIa Carriage. |
|----------------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------------------|-------------------------------------------------|
| WEIGHTS.                                                                         |                                             |                                                        |                                                 |
|                                                                                  | Tons cwt. qrs. lbs.                         | Tons cwt. qrs. lbs.                                    | Tons cwt. qrs. lbs.                             |
| Weight of howitzer (without mechanism) ... ..                                    | 2 14 2 0                                    | 3 3 3 0                                                | 3 5 1 0                                         |
| Carriage with howitzer ... ..                                                    | 8 10 2 13                                   | 8 17 2 0                                               | 8 19 0 0                                        |
| Pressure of trail on ground ... ..                                               | 0 5 1 0                                     | —                                                      | —                                               |
| Limber (complete with stores), when fitted for—                                  |                                             |                                                        |                                                 |
| Pole draught ... ..                                                              | 1 2 0 10                                    | —                                                      | —                                               |
| Engine draught ... ..                                                            | 1 2 2 15                                    | 1 2 2 15                                               | 1 2 2 15                                        |
| Weight on pole at third tug hole, carriage limbered up ... ..                    | 0 0 2 11                                    | —                                                      | —                                               |
| Weight on limber hook ... ..                                                     | 0 5 0 22                                    | —                                                      | —                                               |
| DIMENSIONS.                                                                      |                                             |                                                        |                                                 |
|                                                                                  | Inches.                                     | Inches.                                                | Inches.                                         |
| Height to axis of howitzer, spade buried ... ..                                  | 60                                          | 60                                                     | 60                                              |
| Height to open sight line ... ..                                                 | 62                                          | 62                                                     | 62                                              |
| Height to dial sight line, No. 7 dial sight ... ..                               | 69                                          | 69                                                     | 69                                              |
| Height to dial sight eyepiece, No. 7 dial sight ... ..                           | 62                                          | 62                                                     | 62                                              |
| Maximum height of carriage, in firing position (howitzer hori-<br>zontal) ... .. | 77                                          | 77                                                     | 77                                              |
| Maximum height of carriage, travelling position, dial sight removed ... ..       | 75                                          | 75                                                     | 75                                              |
| Maximum width of carriage over axle ... ..                                       | 95·8                                        | 95·8                                                   | 95·8                                            |
| Track, carriage and limber wheels ... ..                                         | 88                                          | 88                                                     | 88                                              |
| Greatest projection beyond track of carriage wheels, on each side ... ..         | 3·9                                         | 3·9                                                    | 3·9                                             |
| Greatest projection beyond track of limber wheels—                               |                                             |                                                        |                                                 |
| Outriggers folded ... ..                                                         | 3·9                                         | 3·9                                                    | 3·9                                             |
| Outriggers extended ... ..                                                       | 14·5                                        | 14·5                                                   | 14·5                                            |
|                                                                                  | Degrees.                                    | Degrees.                                               | Degrees.                                        |
| Angle of lock ... ..                                                             | 40                                          | 40                                                     | 40                                              |

## PART III.

## SIGHTING.

(FOR MARKS VI TO VIIA CARRIAGES.)

*(Plates XXIV to XXVIII.)*

The carriage is provided with the following sighting arrangements:—

|                                  |                        |
|----------------------------------|------------------------|
| Sight, rocking-bar               | } On left side.        |
| Sight, clinometer                |                        |
| Sight, dial, No. 7               |                        |
| Carrier, No. 7 dial sight, No. 5 |                        |
| Sight, dial, No. 1               | .. .. . On right side. |

SIGHT OPERATING GEAR. *(Plate XXII.)*

The sights on the left side are moved through the same angle as the howitzer by means of a parallel motion operated from the elevating arc. For convenience in laying, the sights are placed as far back as possible and, as they cannot be attached to the cradle, the parallel motion is necessary to transmit the motion from the elevating gear to the sights. When the quick loading gear is worked no movement of the sights takes place as the cradle is then unlocked from the elevating arc, but on working the elevating gear the arc is moved, which, transmitting its movement through the link and rod, causes the sight to be rotated on its pivot.

The upper end of the link on the elevating arc is formed into a crosshead which is slotted to take a sliding bush held in position by two adjusting screws. The screws pass through the front and rear ends of the crosshead respectively, and their points bear against the bush. By means of the bush and screws the sight is adjusted for elevation. To the sliding bush is attached the front forked end of a connecting rod, the rear end of which is attached to the top of the sight bracket by a front and rear securing nut. By manipulating these nuts the correct length of rod for the proper movement of the sight is obtained, when the sight is first set up, or on repair.

SIGHT, ROCKING-BAR. *(Plate XXIV.)*

The sight bracket is pivoted at its lower end to a bracket on the saddle and is fitted with bearings to which is pivoted an oscillating bracket which can be rocked in a plane at right angles to the axis of the piece by the cross-levelling gear. The latter consists of two nuts and a screw with milled head and is interposed between the oscillating and sight brackets; a cross-level carried on the back of the former indicates when the sight is level transversely. By working this gear till the bubble of the cross-level is central any difference in level of wheels is allowed for. The oscillating bracket is in the form of a casing and carries the sight gear, which is protected by a cover secured to the casing by screws.

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NOTE.—In future the cross-level carrier will be secured to a supporting bracket attached to the body of the range bracket instead of being carried on the oscillating bracket.

The sight gear consists of a quadrant or range bracket pivoted at its lower end inside the oscillating bracket; the quadrant is provided with an inside toothed rack. Gearing into the rack is a pinion carried on a cross-spindle on the outer end of which is secured the range drum. Between the drum and pinion, the spindle carries a wormwheel into which gears a worm on the upper end of an oblique spindle at the lower end of which is a handwheel for actuating the gear. To allow of any backlash between the rack and pinion being taken up the pinion is made in two parts. These are so arranged that one may be slightly rotated in relation to the other and locked.

Thrust balls are interposed between the worm and its bearings to reduce the friction caused by end thrust.

The range drum is fitted with a range dial ring graduated to  $50^{\circ}$ , the graduations being indicated by a pointer on the oscillating bracket. The dial ring is held in position by a clamping ring with screws.

In future manufacture the range dial ring will be graduated in whole degrees only, and the reader will be provided with a minute vernier scale, reading from 0 to 60 minutes in multiples of 5 minutes, for the purpose of applying minutes of elevation.

Consequent on this modification the "Ring, range dial," "Ring, clamping range dial" and "Reader, range dial" will each be known as Mark II.

Brackets on the quadrant support the sight clinometer, sight bar, and No. 5 carrier with No. 7 dial sight. The side of the dial sight clamp is cut away and a loose dog clamp is fitted in its place so as to ensure a firm grip on the dial sight.

The sight bar is a tubular steel bar pivoted horizontally near its front end through an eccentric bush in the bracket on the quadrant, in which it is secured by a washer, nut and pin. The front end of the bar carries an adjustable acorn foresight, protected when not in use by a cap with chain, while its rear end is slotted to fit over a projection on the deflection nut.

A bracket is provided on the top right side in which is cut a V notch for use in conjunction with the acorn foresight. The deflection gear is carried in a crosshead formed at the rear of the quadrant and consists of a screw with milled head nut in two parts with spring, scale plate and graduated drums. The scale plate is attached by screws to the back of the crosshead and is graduated to  $5^{\circ}$  right and  $5^{\circ}$  left, the graduations being indicated by an arrow on the nut. The drums fit over the ends of the screw, one on either end and are graduated in intervals of 5 minutes, with indicating arrows on the crosshead. The graduations on the scale plate and micrometer drums are filled in with black wax on a bright metal background and against each numbered graduation the letter "R" or "L" is marked to signify "Right" or "Left" respectively. To counteract for drift the sight is inclined at an angle to the left of  $6^{\circ} 40'$  for the Mark VI carriage and  $4^{\circ}$  for the Marks VII and VIIA carriages and given a permanent correction in the deflection gear of  $1^{\circ}$  right. A red line (at  $1^{\circ}$  left deflection) on the back of the crosshead indicates the position of *true zero* to which the sight must be set for testing purposes.

## CLINOMETER, SIGHT, MARK III.

(Plate XXIV.)

The sight clinometer is used to allow for the "angle of sight," and admits of  $20^{\circ}$  elevation or  $20^{\circ}$  depression. It is constructed so that it may readily be attached to the rocking bar sight. It consists principally of a cradle with a worm spindle and a toothed arc with a spirit level. The cradle is fitted on the underside with spring clips for fixing it to a bracket on the sight gear quadrant and with radial grooves on the top, in which the arc slides; the worm spindle passes through the centre of the cradle and is supported at each end by movable bearings, one of which is pivoted to the cradle, and the other free to slide in grooves for a limited distance so that the worm on the spindle may be readily disengaged from the teeth in the arc when necessary for quick adjustment. The worm is kept up to its work by a flat spring with a bearing surface on its underside and each end of the spindle is fitted with an adjustable micrometer collar marked to read minutes in multiples of five. The arc consists of a toothed segment with a spirit level above; which is fitted with a "P" bubble. The "P" bubble spirit glass is painted with radium compound on its underside, which makes it self-luminous for use at night, and the letter "R" is painted in red on the cradle, in order that clinometers fitted with such bubbles may be readily distinguished. It slides in the grooves on the cradle, and the teeth engage with the worm on the spindle; an adjustable pointer is fitted below the level for reading the degrees of elevation and depression engraved on the cradle.

## CARRIER, No. 7 DIAL SIGHT, No. 5.

The No. 5 carrier consists of a steel bar which can be clamped into a bracket on the quadrant. The upper portion is shaped to take the dial sight. It is fitted with an arrangement for giving deflection up to  $10^{\circ}$  right or left. This consists of an upper and lower bracket.<sup>†</sup> The upper bracket is connected to the dial sight by means of four screws and a feather; fitted through it is a worm with a minute micrometer head at each end, readers for which are fitted on the bracket. A leather dust excluder being attached to the bracket by five screws to prevent the ingress of dust or grit. Along one face is fixed the deflection degree scale. The lower bracket, which is fixed to the carrier, has worm teeth cut on it into which the worm gears. There is also a reader for the deflection degree scale attached to it. Against each numbered graduation the letters "R" or "L" are marked to signify "Right" or "Left" deflection respectively.

## SIGHT, DIAL, No. 7.

(Plates XXV and XXVI.)

The No. 7 dial sight is employed for both direct and indirect laying. The upper part of the sight can be revolved through a complete circle

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<sup>†</sup> In future manufacture of carriers the deflection brackets will be omitted.



independently of the eyepiece, thereby allowing the layer to see objects in any direction without moving the position of his eye. Owing to the form of the sight the layer can lay on objects directly behind him, the line of sight being above his head. A coned seating in the sight rests on a coned projection on the carrier.

*Mark III.*—The optical arrangements are so designed that an object viewed through the sight is always seen erect. They consist of:—

F. The *upper prism*, which is mounted in the upper portion of the sight. Its face can be turned in any direction with reference to the eyepiece K, the angle between the two being indicated on the dial plate and by means of a reader on the bracket N.

G. The *centre prism*, which, by means of bevel gearing, is made to revolve at half the speed of the upper prism F. This arrangement ensures the object layed on always appearing erect.

H. A double reflecting roof prism.

J. The object glass.

K. The eyepiece, with two eyelenses.

M. A glass diaphragm, upon which are engraved vertical and horizontal lines with gaps near their centres; a radium dot is placed just below the optical centre on the vertical graticule and is for use at night.

A glass window in the eyepiece allows the lines to be illuminated at night.

The magnification of the system is four diameters and the field of view is  $10^\circ$ . There are no arrangements for focussing the sight.

The principal mechanical parts are the following:—

B. The *supporting pillar*, in which are suitably mounted the eyepiece K fitted with a dermatine eyeguard, the lower prism H and the object glass J. The “plug supporting pillar,” V, is screwed into its lower end and on it is a castellated nut, which is prevented from unscrewing by a split pin. Near the upper end of the supporting pillar is a coned seating W, which fits accurately on to a coned bearing on the carrier.

The projection X, which fits into a slot in the carrier, prevents the sight revolving.

C. The *wormwheel bracket* is firmly secured to the supporting pillar B. In it is mounted the slow motion traversing gear, which consists principally of a worm spindle S, the worm on which engages with the wormwheel D. On either end of the spindle is mounted a milled head and an adjustable micrometer scale drum. The drums are graduated in opposite directions in divisions of 10 minutes, *right* angles being denoted by white lines on a black background and *left* angles by black lines on a brass background. For future manufacture the distinctive marking will be omitted, the graduations being filled in with black wax on a bright metal background, *right* angles being indicated by the letter “R” and *left* angles by the letter “L.” The drums can be adjusted by loosening the caps inside the milled heads with a special wrench and turning them independently of the milled heads. The readers for the drums are on the worm wheel bracket. Each turn of the worm spindle moves the upper part of the sight through  $5^\circ$ . The



worm spindle is mounted in an eccentric, which, when turned by raising a lever near the left drum throws the worm out of gear with the wormwheel. This enables the upper part of the sight to be revolved rapidly. The rear surface and four screws are for the attachment of the upper bracket of the deflection scale of the carrier.

D. *The wormwheel* has teeth, which engage with the worm spindle S, cut on its lower portion. It extends upwards and is firmly secured to the upper prism holder E and the dial plate A by screws, &c.

Y. *The centre prism holder* fits accurately in the supporting pillar B. To it is attached the prism mount P, in which the centre prism G is firmly held.

The prism holder is free to revolve, and is forced to do so at half the speed of the upper prism holder E, by means of three bevel wheels. The axis of the vertical bevel wheel Z is formed on a projection from the prism holder. This wheel engages with the lower bevel wheel Z<sup>1</sup>, which is fixed to the supporting pillar and also with the upper bevel wheel Z<sup>2</sup>, which is fixed to the upper part of the sight. When the upper part of the sight is revolved the axis of the centre bevel wheel and consequently the central prism, are forced to revolve at half the speed of the upper part of the sight.

E. *The upper prism holder*, as previously mentioned, is rigidly attached to the dial plate and wormwheel. In it are suitably mounted the upper prism and a glass window.

A diaphragm is hinged to the case of the upper prism holder, by means of which the focus and parallax at short distances can be corrected without any appreciable loss of light.

The diaphragm, which is fitted with a shutter, is only for use at short distances of approximately 20 yards or under.

A spring is provided which retains the diaphragm and shutter in position when closed.

In the centre of the diaphragm is a hole .25 inch in diameter, and in the shutter one of .125 inch diameter.

If the object to be viewed is only a few feet away, the shutter is to be used and the object viewed through the small hole.

When the dial sight is used at a distance of more than 20 yards the diaphragm is to be lowered from the front of the window.

To enable the line of sight through the upper prism to be elevated or depressed, a small toothed arc is attached to the mount of the prism. The teeth of this arc engage with a worm spindle R. At the top of this spindle is mounted a milled head with adjustable drum, engraved with a zero mark. The reader is engraved on the prism holder; 17° elevation or depression can be given. The letters "E" and "D" are marked against each numbered graduation to denote "Elevation" and "Depression" respectively.

A crosshead with open sights (or view finder) is mounted on the right side of the upper prism holder. Its movement is regulated by that of the upper prism, but as the latter has a reflecting surface the former has to move twice as quickly. This is arranged for by a toothed wheel on the prism mount gearing with a toothed wheel, having only half the number of teeth, on the pivot of the crosshead with open sights.

Engraved on the under portion of the crosshead is a zero mark, indicated by an arrow on the upper prism holder.

A. *The dial plate*, as previously mentioned, is firmly fixed to the wormwheel and upper prism holder. The dial plate is cast with two lug pieces on it to prevent any play between the dial plate and the case upper prism holder. Two scales, each reading from 0 to 180 in single degrees, are engraved round the dial plate, *right* angles being denoted by white lines on a black background and *left* angles by black lines on a brass background. For future manufacture the distinctive markings will be omitted, the graduations being filled in with black wax on a bright metal background, right graduations being indicated by the letter "R," the left by the letter "L." The graduations are read by a reader on the reader bracket. This reader can be adjusted by loosening two screws in its rear surface and moving it to one side.

The *Mark II* differs from the *Mark III* as follows :—

- (1) The dial plate is not cast with two lug pieces on it.
- (2) The slope of the dial plate is steeper, which causes the reader plate to be slightly lower.
- (3) The boss on the top of the dial plate is slightly smaller in diameter, necessitating a smaller clamping collar and lead lining.
- (4) The vertical scale graduation on the upper prism holder crosshead and the micrometer head, excepting the zero and index marks are omitted.

*Mark I.*—The *Mark I* sight differs from the *Mark II* in the following particulars :—

One of the milled heads on the worm spindle is smaller.

A vertical scale, with graduations to 15° elevation or depression is fixed to the upper prism holder and the micrometer scale drum is graduated in intervals of 10 minutes.

Certain internal parts are of steel instead of bronze.

*Marks I* and *II* sights are brought up to *Mark III* type when passing through Woolwich for repair.

#### SIGHT, DIAL, NO. 1, MARKS I\* AND II.

(Plate XXVII.)

The dial sight consists of a circular carrying plate with degree scale ring, a crosshead and pin and a sight plate with pointer. The carrying plate is hinged at the centre to the crosshead and the crosshead is hinged transversely to the crosshead pin. This arrangement admits of an adjustment right and left to compensate for any difference that may occur in level of the wheels and for elevation or depression being given to the plate and sight. The degree scale ring is fixed to the periphery of the carrying plate by screws; it is marked in degrees (white on black for right side and black on brass for left), 180 on each side of zero, the required angle being read by means of a pointer fixed to the rear end of the sight plate. Should it be found, by examination, that when the sight line and axis of the howitzer are parallel, zero is *not* indicated, the pointer is so formed as to admit of the required adjustment being made. The sight plate is pivoted to the centre of the carrying plate and jointed near its centre; the joint

pin is provided with a thumb nut for clamping the plate in the extended or folded position; the plate is fitted with an acorn-pointed foresight at the front end and notched to form a hindsight at the rear end. A clamping screw is provided to fix the sight plate at the required angle. The sight is fixed to the bracket by the crosshead pin, which fits into a corresponding socket on the pillar and is secured by a keep pin.

#### TESTING AND ADJUSTING SIGHTS.

Any adjustment required to optical arrangements must be carried out by an Armament Artificer.

1. *To test the range drum.*—Lay the howitzer horizontal by means of a clinometer known to be in adjustment. Set the sight gear on stops. Range drum should be reading zero; if not, adjust as follows:—

*Adjustment.*—Slacken the screws securing the retaining plate, revolve drum to zero, and re-clamp.

2. *The bubble of the cross-level should be in the centre of its run when the top of the sight is level transversely.*

*Test.*—Place a clinometer set at zero across the top of the dial sight carrier (having first removed the dial sight) and bring the bubble of the clinometer to the centre of its run by working the cross-levelling gear. The bubble of the cross-level should now be in the centre of its run. If it is not so, then it must be adjusted by an artificer.

3. *The bubble of the sight clinometer should be in the centre of its run when set at zero, with the howitzer laid horizontal, and range drum also at zero.*

*Test.*—Place a clinometer set at zero on top of the clinometer plane of howitzer and bring the bubble to the centre of its run by working the elevating gear of the carriage. Set sight clinometer and range drum at zero. Place the clinometer still set at zero on the top of the carrier of the dial sight; its bubble should be in the centre of its run. If it is not so, adjust by the screws of the sliding bush at the front end till the bubble is in the centre of its run.

*Note.*—This adjustment should seldom be required and should only be made by a qualified artificer.

The bubble of the sight clinometer should now be in the centre of its run; if it is not, adjust as follows:—

*Adjustment.*—Bring the bubble of the sight clinometer to the centre of its run by working the milled head. Slacken the screws securing the reader of the degree scale and the nuts securing the micrometer scales, shift reader and micrometer scales to zero and re-clamp.

#### ALIGNMENT TESTS.

Before carrying out the alignment tests the carriage should be placed on a firm platform, or on hard level ground and manipulated until the howitzer is level transversely. If these arrangements cannot

be conveniently made, the base line of the target (*Plate XXVIII*), if used, must be set parallel to the slope of the wheels.

1. *To ascertain if the lines of sight through the open sights and dial sight are parallel to the bore as regards elevation.*

*Test.*—Set the range drum of the rocking bar sight and the gear rocking the upper prism holder of the No. 7 dial sight at zero. Select a clearly defined object at least a mile away; fix cross lines at the muzzle and, using the axial vent as a sighting hole, lay the bore on the distant object accurately for elevation by means of the elevating gear. The lines of sight through the open sight and dial sight should fall on the same distant object; if they do not, then adjust in following order:—

*Open Sights.*—Slacken the clamping nut at the bottom of the foresight and screw the latter up or down till the line of sight is on and re-tighten clamping nut.

*No. 7 Dial Sight.*—Revolve the milled head at the top of the sight till the latter is on. Slacken the nut securing the micrometer collar, revolve the latter to zero and re-clamp. If the arrow on the side is now not quite opposite the zero mark and confusion is likely to arise, the arrow should be erased and a new one scribed opposite the zero mark.

*Note.*—After carrying out the above adjustment the sight clinometer must be re-tested.

2. *To ascertain if the lines of sight through open sight and dial sight are parallel to the bore as regards line.*

*Test.*—Set range drum of the rocking bar sight at zero and deflection gear of dial sight carrier at  $1^{\circ}$  left. Set the deflection gear of the rocking bar sight to the red mark on the scale (true zero) and lay the bore on the distant object accurately for line. The lines of sight through open sight and dial sight should be on the distant object. If not, adjust as follows:—

*Open Sight.*—Slacken the clamping nut at the bottom of pivot of sight bar and nuts of cotter pin. Ease the cotter slightly and, by means of a spanner, turn the eccentric bush until the open sight is on, and re-clamp.

*Dial Sight.*—Bring the dial sight on to the distant object by the deflection gear of the carrier. Slacken the screws securing the reader of degree scale and nuts of micrometer scales, shift the reader to  $1^{\circ}$  left and scales to zero and re-clamp.

Should a distant object not be available a target must be constructed as shown in *Plate XXVIII* and set up about 50 yards in front of the muzzle. Then, with the bore laid on B, the open sight and dial sight must be adjusted on O and D, respectively, both for elevation and line.

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[Issued with Army Orders for February, 1921.]

HANDBOOK OF THE B.L. 8-INCH HOWITZERS, MARKS VI TO VIII ON  
TRAVELLING CARRIAGES, 1920.

*Amendment.*

Page 34.

*After last line on page, add the following :—*

*“ Test of Sight Operating Gear.*

(“ NOTE :—The sight should occasionally be tested for wear of the link motion.)

“ Having carried out Test 1 on page 33, lay the howitzer at 15 degrees elevation with a field clinometer ; bring the bubble of the sight clinometer to the centre of its run by the range handwheel. The range drum should read 15 degrees. If it does not, note the reading. Repeat this procedure at 30 degrees elevation.

“ If the error at 15 degrees exceeds 5 minutes, or if at 30 degrees it exceeds 15 minutes, the sight and sight operating gear should be sent to Ordnance Workshops for repair.”

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## PART IV.

## LIMBERS, &amp;c.

LIMBER, B.L. 6-IN. GUN AND 8-IN. HOWITZER, MARK III.

(Plates XXIX to XXXI.)

*Frame.*—The limber consists of a framework which comprises four futchels of flanged steel connected by a trough-shaped splinter bar at the front and by a plate in the centre and rear. To the back of the centre futchels is riveted a steel limber hook with feathered key. Each centre futchel is connected to the splinter bar by a round diagonal stay.

*Axletree and wheels.*—The axletree is of steel, circular in section, with special axletree arms. It passes through bearings formed in the futchels and is held in position by brackets which are feathered to the axletree shoulders and bolted to the outside futchels. The outer end of each arm is prepared to take a cap with securing pin.

The wheels, Special No. 91, are of steel, 5-feet 6-inches in diameter, having a sole 6 inches wide with rounded edges. A lubricator is fitted to each wheel.

They are held on the axle arms by a dragwasher, cap and a pin which passes through the cap and axletree arm, and is held underneath by a split pin.

*Limber box.*—The limber box is of deal and is bolted to the top rear of the futchels. The lid, which is covered with water-proofed canvas, is hinged to the front and secured in rear by a hasp and turnbuckle.

The top of the box is fitted with guard irons and blanket straps. There are also fittings on the sides and ends to take a felling axe, shovels, &c.

The box is fitted internally to carry tools, spare packings for buffer and recuperator, &c. Clips are fitted to the front of the box for two rifles

*Fittings for draught.*—The splinter bar is fitted to take a No. 2 connector for traction draught, which is the normal method of transport.

The No. 2 connector is V-shaped, formed with an eye at the apex for connecting to a tractor, and with lugs at the forked ends for attachment to the loops of the futchels. It is fitted with a draught bolt with a volute spring. The spring is retained between the apex of the V-shaped link and a bearing plate by two collar stays and the bolt which passes through the spring, link, and bearing plate. An eye is formed at one end of the bolt for attachment to a tractor.

In addition, a staple for a No. 19 pole, with No. 4 pole bar for horse draught, is fitted between the centre futchels at the front, and a socket for the end of the pole is fitted between them just in front of the axletree.



The splinter bar is fitted with draught hooks for the No. 12 swingle-trees, but, to enable quadruple horse draught to be used, outriggers, for the swingle-trees of the two outside horses, are hinged to each end of the splinter bar. When in use the outriggers are braced by a stay connected to the loop of the dragwasher.

NOTE.—*In future limbers will be issued without fittings for horse draught.*

#### METHOD OF TRAVELLING EN-TRAIN.

When mechanical transport is employed, engine draught connectors and intermediate couplings are provided in order that, if required, two equipments may be travelled en-train, as under, by means of one connector and two intermediate couplings :—

|             |    |    |    |    |    |          |
|-------------|----|----|----|----|----|----------|
| 1st vehicle | .. | .. | .. | .. | .. | Carriage |
| 2nd „       | .. | .. | .. | .. | .. | Limber   |
| 3rd „       | .. | .. | .. | .. | .. | Carriage |
| 4th „       | .. | .. | .. | .. | .. | Limber   |

*Connector, Engine draught, No. 12.*—This is of steel, in two portions. The rear portion consists of a socket suitably recessed to take the trail eye of the carriage, and is provided with a connecting pin to retain the eye in position, and bolts to secure the socket to the front portion, which consists of two side plates, front plate, volute spring, front and rear spring bearings, spring bolt and spring bolt guide block, the spring bolt being formed with an eye to engage with the jaw of the tractor.

*Coupling, intermediate draught.*—The intermediate draught coupling is of steel, and consists of a top and bottom plate, which are secured at one end to an eye, by means of which it is connected to the rear draught bracket of the carriage, a large channel stay, two connecting pin bearings, secured between the plates centrally, with a small channel stay fitted to the other end. A connecting pin with key is provided, which enables the draught coupling to be attached to the No. 2 engine draught connector on the limber, the rear end of the intermediate coupling housing in the pole socket of the limber.

#### PLATFORM, FIRING.

(Plates XXXII-XXXV.)

The firing platform consists of a triangular frame of wood, at the apex of which is placed a wheel stage (*see Plate XXXIV*).

It is intended to provide a reliable support for the wheels and the rear end of the trail, so as to prevent sinking or movement when firing on soft ground (thus ensuring the howitzer remaining on the target when firing), and also to facilitate traverse.

The beams are marked at one end (the travelling rear) with figures to ensure that they are laid correctly for travelling (*see Plate XXXV*), and both wheel stage and beams are provided with wire rope grummetts for lifting purposes. The rear beams are also provided with lashing eyes for securing the tool box.

The platform consists of the following principal parts:—

Beams, side.  
Beams, rear, top and bottom.  
Stage, wheel.  
Clamps.

The *side beams* are left and right respectively. They are strengthened by steel bands at each end and faced with steel plates.

The beams are hinged at their front end by means of hinge plates and hinge pin, and are provided with clips on their upper side to take the axletree of the transporting carrier and with angle brackets for securing the wheel stage and rear beams.

In addition, the right beam is fitted with an eye for haulage purposes, which is used in conjunction with a hauling hook attached to the rear draught link of the carriage.

The *Beam, rear, bottom*, is strengthened by steel bands at each end, and has steel faced slots formed in the upper side for housing the side beams.

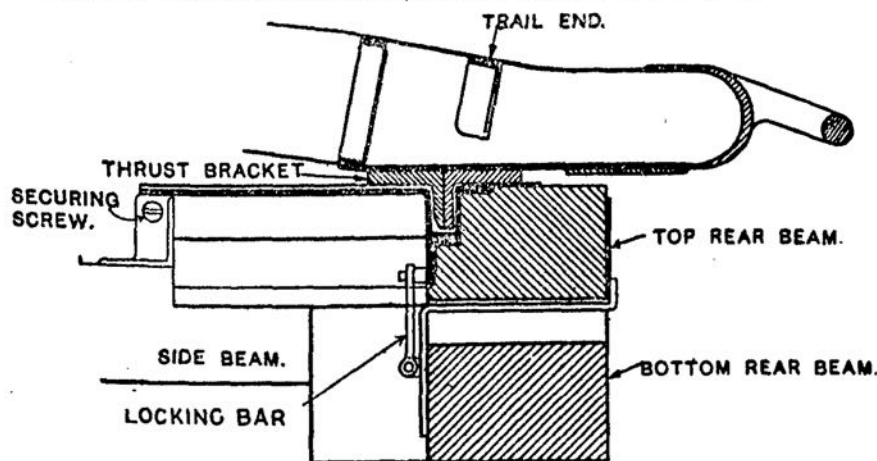
Two Z-shaped steel clip plates are bolted about its centre, each plate being furnished with an eye for a locking bar with bolt and nut, by means of which the bottom and top beams are locked together when in position.

A steel wire rope, the ends of which are secured by steel clips, is passed from the hinge pin of the side beams to a hook passed through the rear beam, the hook being nutted up to a backing plate on the rear of the beam and provided with four Belleville washers to absorb the shock on recoil and prevent straining the rope by over-tightening.

A slot for the axletree of the transporting carrier is formed on top of the beam at its centre.

The *Beam, rear, top*, is strengthened by steel bands and faced with steel plates. A slot, faced with steel plate, is formed at each end for the reception of the side beams.

A circular steel channel, bolted to its upper surface, forms a guide for the thrust bracket on the trail to traverse in, and prevents any rearward movement on recoil (see *Plate XXXIV* and *Fig. 1*).

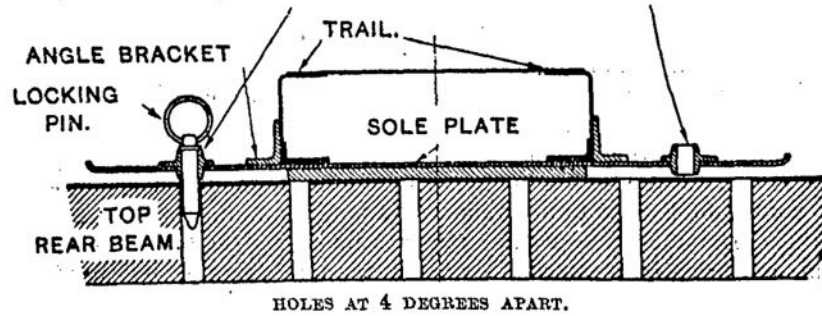


SECTION THROUGH REAR BEAMS ON CENTRE LINE OF TRAIL

FIG. 1.

A traversing stop is fitted at each end of the channel, and holes are spaced at  $4^{\circ}$  interval in the flange of the track for locking the trail at various angles of traverse (see Fig. 2). In addition, graduations,

ALTERNATIVE HOLES FOR LOCKING PIN, ALLOWING MOVEMENTS OF 2 DEGREES TO BE OBTAINED WITH THE TRAIL.



SKETCH SHOWING METHOD OF SECURING TRAIL WHEN FIRING.

FIG. 2.

at  $2^{\circ}$  interval, are marked on the top of the beam, and are read by means of straightedges cut in the soleplate of the trail. The total traverse obtainable, including that of the carriage, is  $30^{\circ}$  Right and Left.

The *Stage, wheel*, on which the carriage wheels rest when in position (see Fig. 3); consists of a number of baulks which are laid transverse to the centre line of the platform, and are secured by steel top and bottom plates.

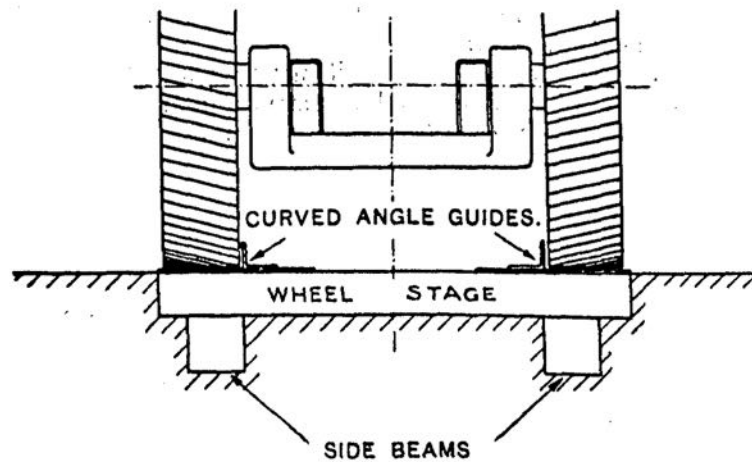


FIG. 3.

The top plates have curved bulb angle plates riveted on their upper surface, which form guides for the carriage wheels and prevent lateral movement on firing, and have straight angle plates riveted on their underside at the rear.

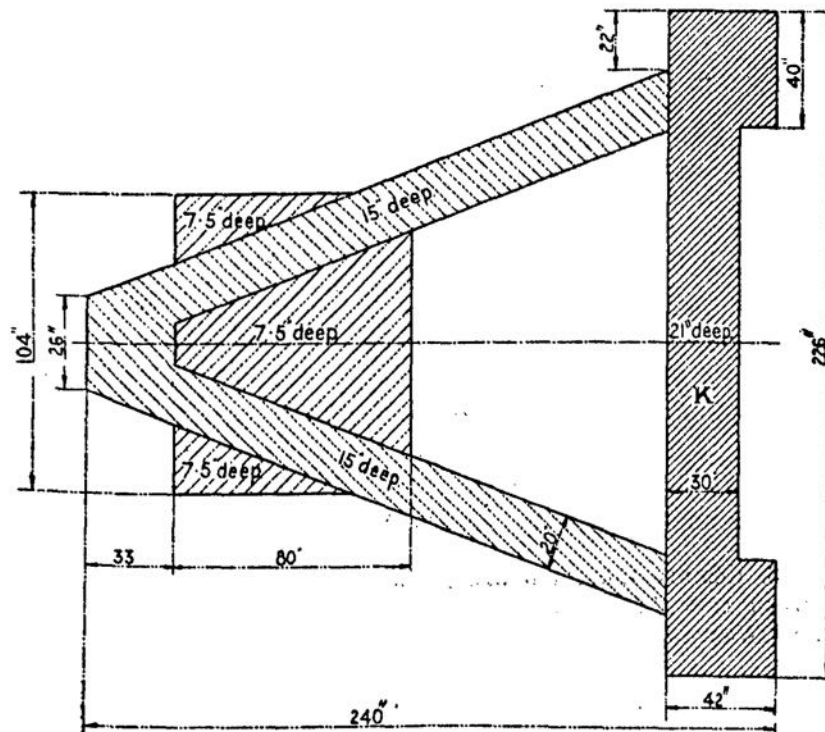
Two wood supports are bolted longitudinally on top of the wheel stage, and are provided with lashing eyes for securing the wood bearers in position when travelling.

*Clamps.*—The clamps are used for securing the side and rear beams together when in position, and consist of two steel bars, upper and lower, and two T-headed bolts with nuts. The lower bar is secured to the underside of the bottom rear beam by two screws, and is slotted at each end to receive the heads of the T-headed bolts.

|                             |    | Tons. | cwts. | qrs. | lbs. |
|-----------------------------|----|-------|-------|------|------|
| Total Weight of Platform    | .. | 2     | 11    | 1    | 0    |
| Weights of principal parts: |    |       |       |      |      |
| Wheel, stage                | .. | 0     | 7     | 2    | 0    |
| Two side beams (each)       | .. | 0     | 9     | 0    | 0    |
| Rear beam, top              | .. | 0     | 14    | 0    | 0    |
| Rear beam, bottom           | .. | 0     | 9     | 3    | 0    |
| Clamps and Tools            | .. | 0     | 2     | 0    | 0    |

#### INSTRUCTIONS FOR LAYING THE FIRING PLATFORM.

##### *Excavating for Beams.*



PLAN OF EXCAVATION.

FIG. 4.

1. Mark out the ground, using small stakes, pegs, or other suitable means for limiting the amount of excavating to that which is only required by the beams as shown.

2. Dig the trenches for the beams to the outlines and depths indicated.

#### DISMANTLING TRAVELLING LOAD.

(Plate XXXV.)

1. Remove the four bearers, tool box and wheel stage A and place the latter in readiness for putting in position on the beams later.

2. Lower the beams together to the ground by means of the raising screws E (Fig. 5), nuts H, and ratchet levers.

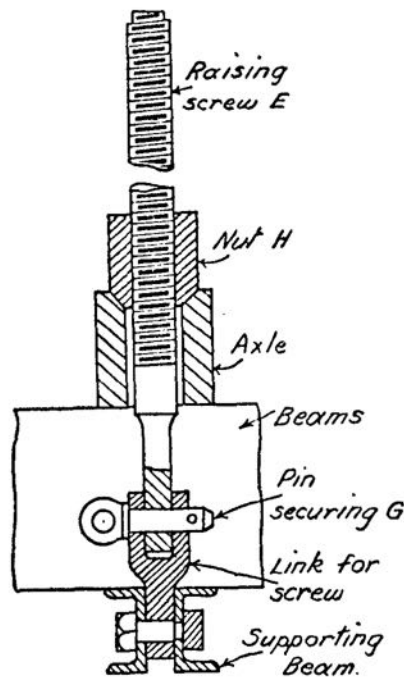


FIG. 5.

3. Remove the chain fastenings F at each end, disconnect the raising screws E by taking out pins G, take away the wheels, axle and raising screws, until required again for transporting.

## ASSEMBLING BEAMS.

RECESS N IN REAR BEAM.

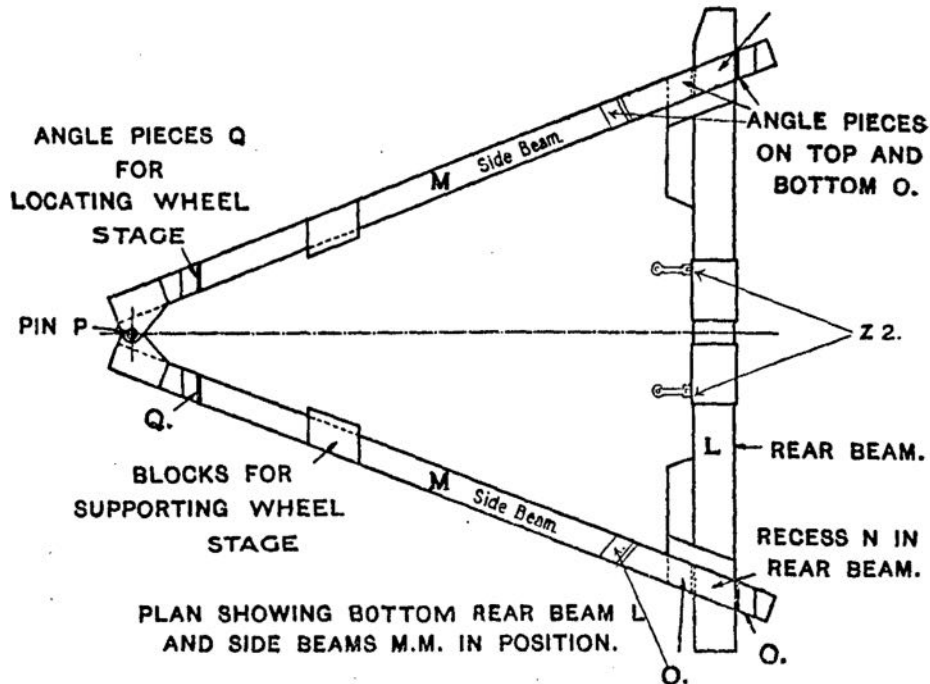


FIG. 6.

1. Place the bottom rear beam L into the trench at K (Fig. 4) by means of the bearers and rope grummets provided. The locking bars Z 1 (*Plate XXXIV*) should also be placed into position.

2. Lower the two side beams M into position with the rear ends resting on the rear beam, the exact position being located by the recesses N, in the rear beam, and the steel angles O on the side beams.

3. Secure the front ends of the side beams together by means of the pin P, one end of the wire rope being attached to the pin at the same time.

## ASSEMBLING BEAMS.

(*Plate XXXIV.*)

4. Remove the screwed pins Z 3 and place into position the top rear beam S, which is registered by the recesses cut into it for the side beams and the steel angles O, which are secured to the side beams.

5. Lock the top and bottom rear beams together, at the junction of the side beams, by means of the steel clamps Z and bolts Z 1 at each end, and near the centre, by means of the two locking bars Z 2.

6. Secure the top rear beam to the side beams by means of the screwed pins Z 3.

7. Connect up wire rope to hook in bottom rear beam and tighten up by means of nut.



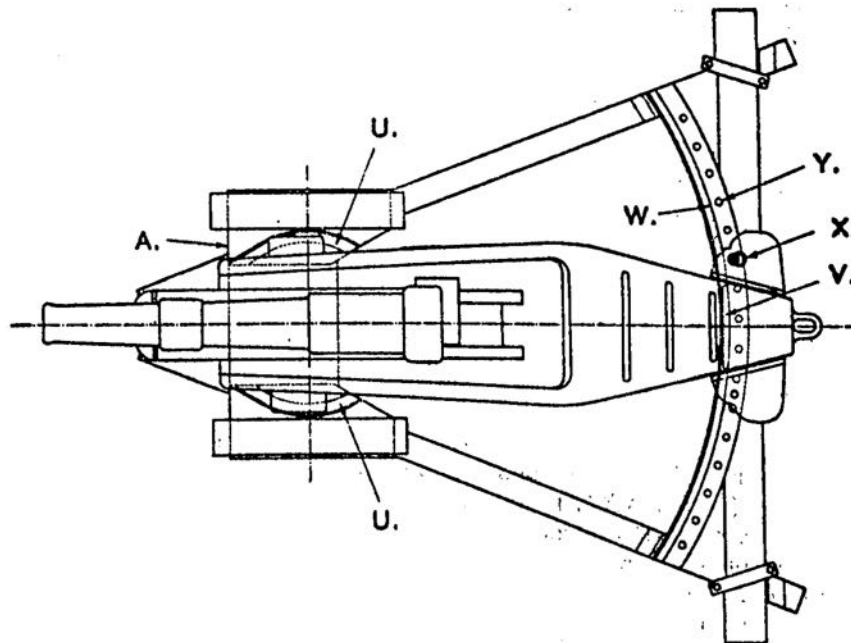
## ASSEMBLING WHEEL STAGE.

(Plate XXXIV.)

The wheel stage A may now be placed into position on the side beams with its forward end against the steel angles Q (Fig. 6), the angles R on the wheel stage registering it laterally.

## FILLING IN AND LEVELLING THE GROUND.

Ram in the earth where required to make flush with the ground level, taking care to leave the ground cut away to clear breech end of howitzer at full recoil.



PLAN SHOWING CARRIAGE IN CENTRAL POSITION ON FIRING PLATFORM.

FIG. 7.

## ASSEMBLING CARRIAGE ON FIRING PLATFORM.

Wheel the carriage into position on the platform, with the carriage wheels outside the angle guides U on the wheel stage A. Lower the rear end so that the curved rib V on the thrust bracket fits into the channel W in the top rear beam, then place the pin X in the trail into one of the holes Y in the rear beam to suit required position of traverse, and place clips securing trail to platform in engaged position.

## CARRIER, TRANSPORTING FIRING PLATFORM.

The carrier, transporting firing platform, consists of a steel axletree (special No. 24) and 2 wheels (special No. 96), which are secured on the axletree by means of collars and pins, a supporting beam, consisting of two lengths of channel steel riveted together, 3 wood strong-backs each with chain, clamping screws and nuts, 2 raising screws and 2 drag washers.

For travelling, the beams of the firing platform are placed side by side on the ground across the supporting beam and clamped together at the ends by means of 2 chains passed underneath and secured by clamping screws and nuts to the strongbacks which are placed across the top of the load.

The wheels and axle are then brought into position over the beams and the load raised by means of the raising screws, which are passed through the axle and are connected by links to the ends of the supporting beam. The raising screws are actuated by ratchet levers and are provided with a locking device to prevent them running down when travelling (see Fig. 8).

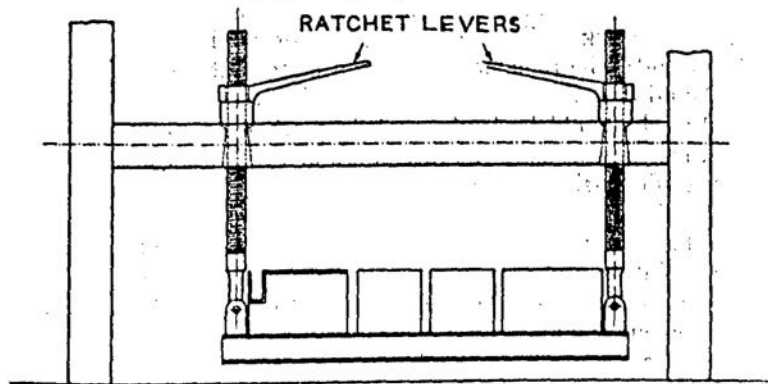


FIG. 8.

The wheel stage is laid on top of the axle after the beams are in position and is secured by the remaining strongback laid across the centre of the load. The 4 bearers and tool box are then secured in position by means of lashings.

The transporting carrier is connected to the rear draught link of the carriage by means of a hauling hook and a hauling eye provided in the right side beam.

When assembled for travelling with the firing platform the estimated weight on the ground is  $3\frac{1}{4}$  tons.

## PART V.

## CARE AND PRESERVATION.

(See also "Regulations for Magazines and Care of War Matériel.")

## HOWITZERS AND FITTINGS.

The breech fittings and also the projections on the exterior of the howitzers, which form guides for the latter when in the cradle, should be kept clean, oiled or greased, and maintained in good working order; all working surfaces must be well lubricated, the fittings being taken off sometimes for this purpose.

The lubrication of the gun-slides is automatic and only takes place when the howitzer recoils on firing. As occasion offers, therefore, the lubrication of the slides should be attended to, so as to make sure that they are always well lubricated and that there is sufficient lubricant in the recesses in the side cover plates.

The threads of the breech screw should be free from burrs; should the screw not work easily when the obturator has been detached, the defect may often be remedied by careful filing, but no portion of the thread should be cut away to remove a crack, &c.

The breech should be kept covered up when possible, to prevent dust and grit getting into the interstices of the breech fittings which might impede their easy working. A cover is provided for this purpose.

The obturating pad should be examined to see that the canvas covering is intact and in proper order for use. If the canvas cover is found to be loose, or to overlap either of the protecting discs, the obturator should be exchanged.

The spare pad will be kept under compression in the "Box, obturator."

The protecting discs should also be carefully examined and if the tin be fused, or the steel rings eroded, burred, or cracked, should be replaced by new discs.

When fitting the pad and discs on the vent, axial, care must be taken that they are in correct order. The face of the pad marked front should be towards the muzzle. One or more steel adjusting discs may be required between the obturator and the face of the breech screw when the pad is compressed by firing, but the obturator should always turn freely.

The obturating pad should be a close fit in the coned seating in the howitzer when the breech is closed.

In order to ascertain this, slightly cover the seating with grease (a mixture of oil and tallow), then close and open the breech, the outer end of the pad should now be covered with grease from contact with the greased seating in the howitzer. When it is found, after the above test, that the pad does not fit the seating closely, adjusting discs should be added until the breech closes tightly and

with some difficulty. The breech should then be opened and closed until the pad of the obturator becomes compressed. Before use, the pad and discs should be well covered with tallow.

Every opportunity should be taken to keep the obturator and vent, axial cool. This can be done by pouring water over it in position, or by sousing it thoroughly with the sponge during or after firing.

After a long, rapid, firing series, the vent head becomes exceedingly hot and the pad very soft; when this is the case, it should be thoroughly soused with water before taking apart.

When a new pad is brought into use it should be expanded with a full charge.

#### CARRIAGES, &c.

*Cradle.*—The guideways on the cradle, in which the howitzer and cylinder block slide, should be kept clean, free from burrs and well lubricated.

*Elevating gear.*—To be kept clean, well lubricated and the teeth of pinions and wheels, greased. If there is any play in the gear, it should be taken up by manipulating the adjusting bush at the lower end of the worm shaft, having first removed the cover.

*Traversing gear.*—To be kept clean and well lubricated.

*Brake gear.*—Must be kept clean and well lubricated. Worn blocks must be replaced by new ones, which are carried spare.

*Cradle clamp.*—Must always be used when travelling to prevent any strains coming upon the elevating and traversing gears. Before connecting to the cradle, it should be seen that the traversing indicator is at zero, and that the plungers of the quick loading gear are withdrawn from their recesses in the elevating arc and saddle, and the handle of the actuating lever is engaging the pawl, where such is fitted.

*Hydraulic buffer and recuperator.*—Before firing, careful attention should be given to the following points:—

- (i) That the hydraulic buffer is correctly filled and that the correct quantity of reserve oil is in the tank where fitted.
- (ii) That the recuperator is correctly charged with both liquid and air.
- (iii) That there is no leakage at the stuffing-boxes.
- (iv) That the cylinder block is securely nutted up to the howitzer lug and that the piston rod of the buffer and rams of the recuperator are properly secured to the front cap.
- (v) That the cut-off gear is in correct adjustment.
- (vi) That all gears and working surfaces are clean and well lubricated (for list of lubricating holes *see* page 60).

#### WARNINGS.

A.—Before removing the front cradle cap steps must be taken to prevent the howitzer from slipping back, either by lashing it firmly to the cradle or by placing a bar through the holes in the rear of the cradle and interposing a wood block between the bar and howitzer.

Similar precautions must be taken should it be necessary at any time to empty the system of air pressure.

If the cradle cap is to be left off for a long time, the elevating hand wheel should be taken off.

B.—On no account must oil be added to the recuperator after filling; should sufficient oil have been lost to reduce the pressure below 550-lbs. per square inch (600-lbs. for Marks VII and VIIA Carriages), the recuperator must be completely emptied and refilled.

C.—Every care must be taken to lay and maintain the cradle perfectly level in order to ensure correct filling (see Figs. 1 and 2). This is very important, as with the cradle elevated only half a degree 6-pints, and with one degree  $12\frac{1}{2}$ -pints, too much oil can be put in before it will overflow at holes "D" and "E." (See Figs. 3 and 4).

D.—Care should be taken to see that plugs are removed from both holes "D" and "E" (see Fig. 3), as if either plug is left in when filling and the cradle is not level crosswise, too much oil may be put in and cause serious damage to recuperator.

E.—The greatest care must be taken to see that the recuperator is correctly filled, as too much oil may cause serious damage and put the howitzer out of action. When properly filled the recuperator should contain 64 pints of oil, and this amount must never be exceeded.

F.—If the oil is pumped into the recuperator very rapidly it may begin to overflow at hole "D" before it has had time to fill up in the other H.P. cylinder to the level of hole "E" owing to the viscosity of the oil. Should this occur, stop pumping for a few moments to allow oil to settle to its proper level in both cylinders and then resume pumping.

G.—It is essential that the oil used in the buffer and recuperator should be clean and free from grit, as sand or grit will cause damage to the working parts. The oil should be strained before use.

H.—If the cradle cap is removed and the recuperator is charged with air the securing collar of the recuperator ram must on no account be removed without first releasing the air pressure. The collars bear against the stuffing-box caps and prevent the rams from being forced out to the rear when under pressure and disconnected from the cradle cap.

I.—Should it be necessary at any time to remove from either H.P. cylinder the front end plug which contains the holes and plug D or E, care must be taken to see that both holes are practically on the vertical centre line in the bottom (see Fig. 5) when the plug is replaced and the joint made tight.

J.—It is important that the buffer should be kept full when in action, as a buffer only partly full means a violent recoil and a wrecked carriage. The tank where fitted should therefore be kept full and the howitzer elevated slightly from time to time and the snifting valve operated, for, if there is any air in the buffer oil cannot flow from the tank until air is expelled. Should the tank or connecting pipe be damaged so as to render them unserviceable, the elbow connection at rear end of cradle should be removed and replaced by the solid steel "plug, tank inlet," provided, which should be screwed down hard. (See Fig. 8.)

K.—Great care should always be taken, when replacing the front plugs, stuffing-boxes, &c., after any of them have been removed for any purpose, that the locking plates with which they are provided are also replaced.

L.—During severe weather, buffers and recuperators should be protected as much as possible from the cold by covering them with sandbags, sacking or straw, &c., and, when possible, by keeping gun pits warm by means of braziers or stoves. If this is done oil should be efficient at temperatures down to 0° F.

M.—Care must be taken that the wood depression stop is always in place, as shown in Fig. 9.

The wood block is provided to stop the cradle at the loading angle ( $7\frac{1}{2}^{\circ}$  elevation), and to relieve the locking bracket on the right side of the saddle of the shock of bringing howitzer and cradle to rest.

If the wood block is not in the position shown damage may be caused to the loading gear brackets. It should, therefore, never be moved from this position except for firing below  $7\frac{1}{2}^{\circ}$  elevation, or when requiring to fill or empty the hydraulic buffer or recuperator, as indicated in the following pages.

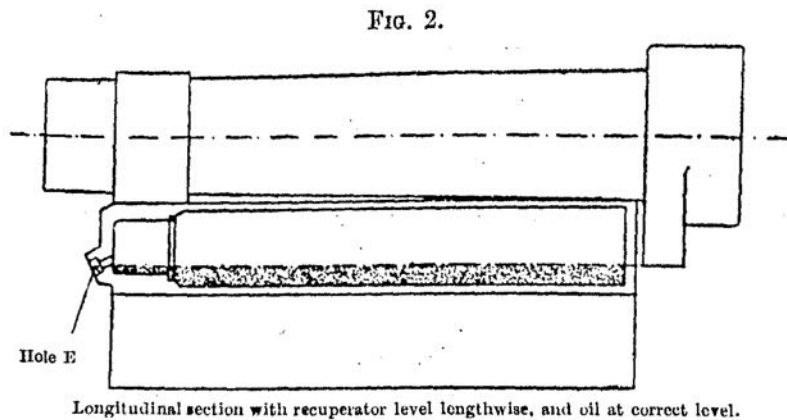
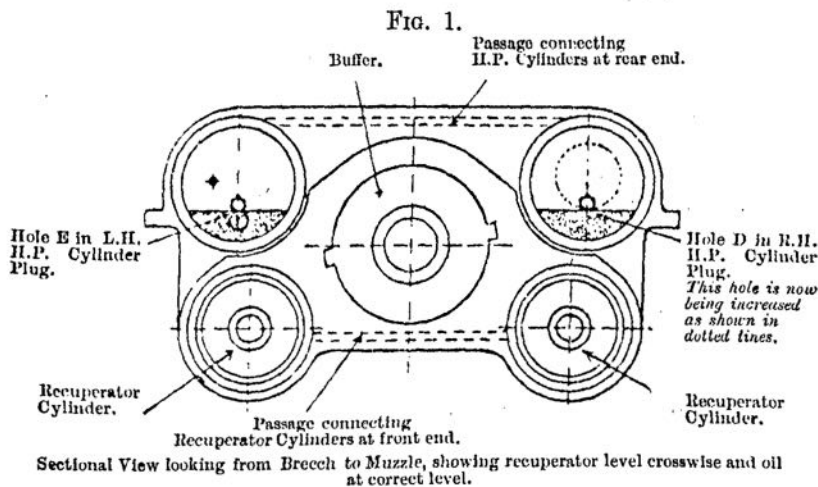
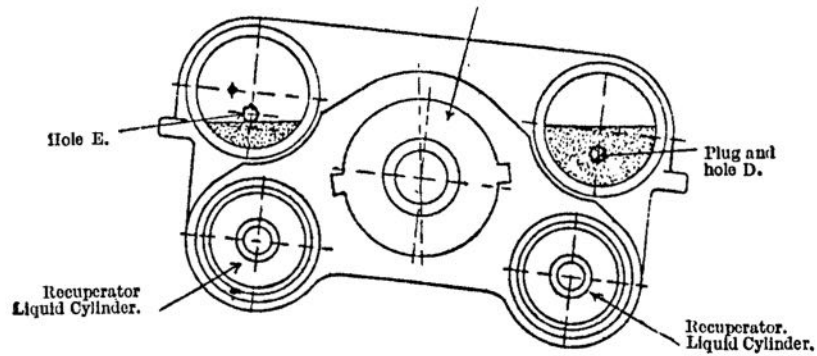
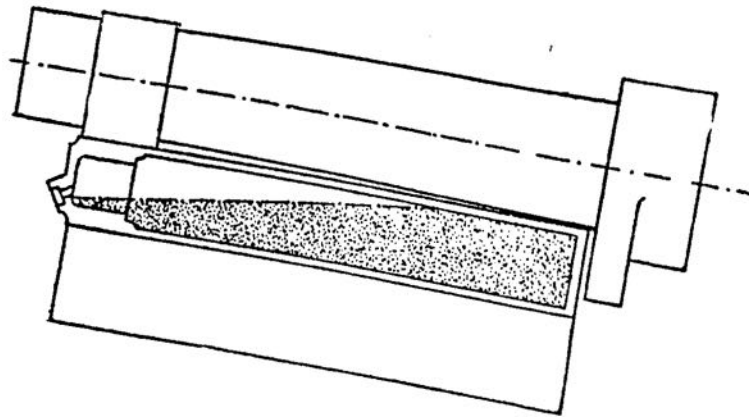


FIG. 3. Buffer.



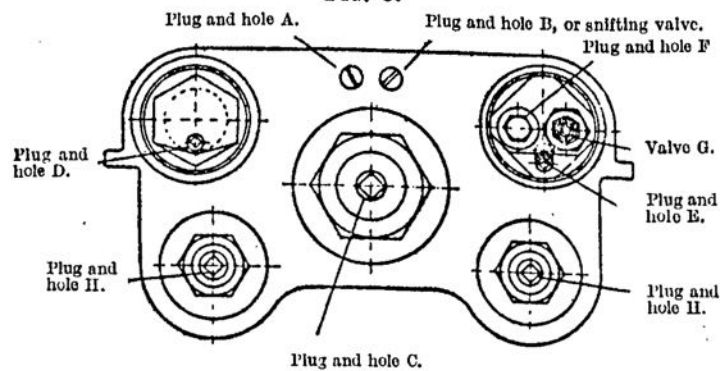
Recuperator out of level crosswise, showing dangerous excess of oil through plug not being removed from hole D.  
Sectional View looking from Breech to Muzzle.

FIG. 4.



Recuperator out of level lengthwise, causing dangerous excess of oil.

FIG. 5.



View of front end of recuperator with cradle cap removed.



FIG. 6.

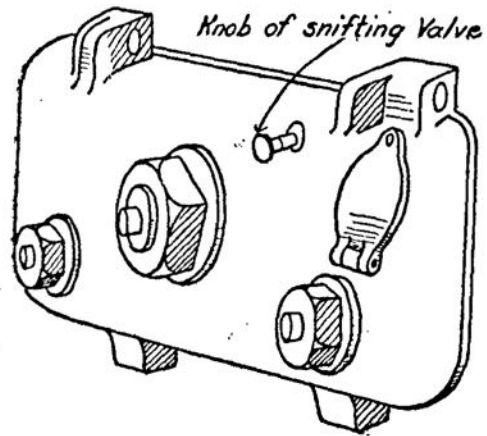


FIG. 7.



FIG. 8.

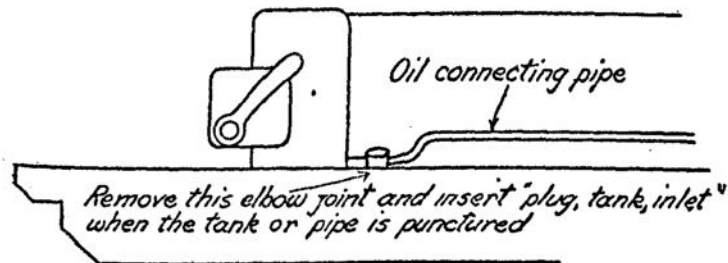
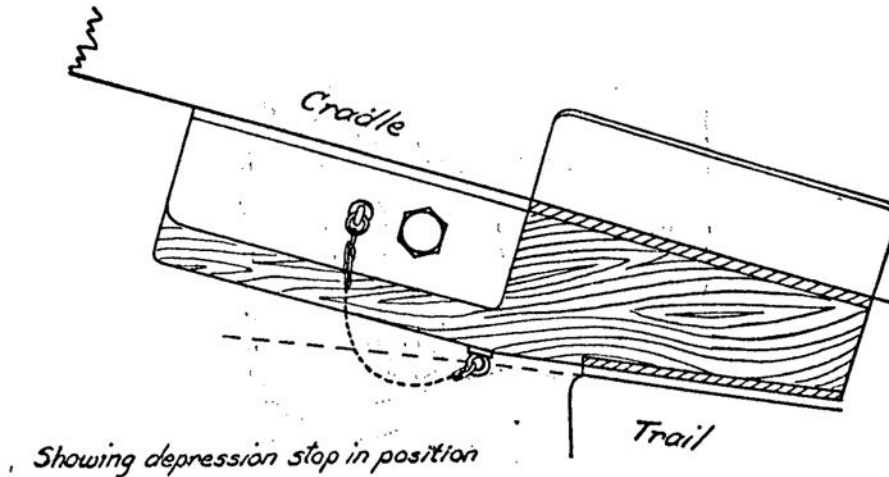


FIG. 9.



To charge the recoil system.—This should be carried out in the following order:—

1. Charge recuperator with oil.
2. Charge H.P. cylinder with air.
3. Fill the hydraulic buffer.

#### RECUPERATOR.

To charge recuperator with oil:—

- (a) Lash howitzer to cradle; remove depression stop; disconnect cut-off gear and remove front cradle cap. (See WARNING "A").
- (b) If the system has been charged with air, remove plug "F" and open valve "G" to release air pressure.
- (c) See that recuperator is quite empty before commencing to fill. (See WARNING "B"). (For method of emptying see page 55).
- (d) Set cradle horizontal, longitudinally and transversely, to a clinometer known to be in adjustment. (See WARNING "C").
- (e) Remove plugs "D" and "E," also plug "H" below plug "E." (See WARNING "D").

NOTE.—The plug and hole "D" in the right H.P. cylinder are now being made of larger diameter, with hole "D" concentric with the cylinder, but the bottom of the hole level with the bottom of the hole "E" in the left H.P. cylinder, as before. (See Fig. 1).

- (f) See that bucket of liquid pump is empty, and then measure in exactly 33 pints of service buffer oil. (See WARNINGS "E" and "G").

- (g) Attach pump connection and adapter, oil filling at hole "H," which is below hole "E," and pump in oil. Cease pumping when the pump begins to draw in air with the oil. One pint of oil will then remain in the bucket and pump barrel, being below the pump suction level. Remove pump connection and adapter and replace plug "H" quickly to avoid losing oil.
- (h) Add a further 32 pints by measure to the pint of oil remaining in the bucket from the first pumping.
- (i) Remove plug "H," which is below hole "D," and attach pump connection and adapter, oil filling, and resume pumping till liquid overflows at holes "D" and "E," which should occur when the pump begins to draw air with oil. Remove pump connection and adapter and replace plug "H" quickly to avoid losing oil. Replace plugs "D" and "E." (See WARNING "F").
- (j) Replace front cradle cap, taking care to see that the securing collars are on the rams, with the locking stud in the correct position to engage between the pegs on the inside of the cap, secure piston rod and rams to cradle cap, connect up cut-off gear, and replace depression stop.

*To make up liquid to correct quantity after leakage.*—If the quantity of liquid lost is sufficient to reduce pressure below the minimum working pressure of 550 lbs. in the case of *Mark VI* carriage and 600 lbs. for the *Marks VII* and *VIIA* carriages, the recuperator must be completely emptied and refilled. (See WARNING "B").

*To charge recuperator with air :—*

- (a) Before charging recuperator with compressed air, see that it is filled with the correct quantity of liquid.
- (b) If the cradle cap is not in position, it is very important to see that the securing collars are on the recuperator rams. The collars bear against the stuffing box caps and prevent the rams from being forced out to the rear when under pressure and disconnected from the front cradle cap. Care should be taken during pumping to see that these collars bear only against the stuffing box caps and not on the gland sleeves. (See WARNING "A").
- (c) If the front cradle cap is in position, care should be taken to see that the piston rod of buffer and rams of recuperator are properly nutted up to the cap.
- (d) Attach air compressor to clips on trail and connect up copper piping to the delivery fitting of the compressor. (For instructions for working the air compressor see page 63).
- (e) Remove plug, adapter hole, "F," and attach pressure gauge adapter with pressure gauge in position. (See *Plate XVIII*).
- (f) Remove cap from adapter, pressure gauge, and connect up pipe from air compressor, taking care to see that all joints are properly screwed up.

- (g) Open valve "G" and pump up until pressure gauge registers 685 lbs. per square inch. (740 lbs. for *Marks VII* and *VIIA* carriages).
- (h) Close valve "G" and disconnect compressor pipe from adapter and replace cap on adapter.
- (i) Open valve "G" and verify pressure.
- (j) Close valve "G" and tighten lock nut till it just grips. Remove adapter and pressure gauge and replace plug, adapter hole, "F."
- (k) If not already in position, replace front cradle cap, nuts securing piston rod and recuperator rams, and connect up cut-off gear.
- (l) Remove howitzer lashings.

*To test the air pressure.*—Remove depression stop and lay howitzer level, and swing shutter of cradle cap clear. Remove plug "F" from adapter hole in left H.P. cylinder, and place adapter, pressure gauge, in position, blanking one end by the adapter cap. Attach pressure gauge to adapter, open valve "G," and gauge should register 685 lbs. per square inch (740 lbs. with *Marks VII* and *VIIA* carriages). If it does not, more air must be pumped in, as described under "*To make up air pressure after leakage.*" If correct, close valve "G," remove adapter with pressure gauge, and replace plug "F." Replace shutter of cradle cap and also depression stop.

*To make up the air pressure after leakage.*—Proceed as for charging recuperator with compressed air, but before opening valve "G" to admit air into H.P. cylinder, pump the pressure up to 685 lbs. per square inch (740 lbs. for *Marks VII* and *VIIA* carriages) in the pipe.

If on examination it is found that the pressure is between 550 lbs. and 685 lbs. (600 lbs. and 740 lbs. for *Marks VII* and *VIIA* carriages), it is not considered necessary to interfere with the liquid, but simply that the air pressure should be raised up to 685 lbs. (740 lbs. for *Marks VII* and *VIIA* carriages), and only when pressure has fallen below 550 lbs. (600 lbs. for *Marks VII* and *VIIA* carriages) should the recuperator be emptied of both air and liquid and recharged.

*To tighten the glands.*—Proceed as described under this head for Hydraulic Buffer, page 54.

*To replace fibre packing washer in stuffing-box.*—The system must be emptied as described under "*To empty the recoil system*" on page 55. The defective washer may then be replaced by new, the fittings replaced in the reversed order, and the system recharged. Opportunity should be taken to examine the L-leather or rubber, and also the compressed packing ring, to see that they are in good working order.

*To replace L-leather or rubbers, compressed packing ring, glands, gland sleeve or gland spring.*—The system must be emptied as described under "*To empty the recoil system*" on page 55. The procedure is then similar to that given for the replacement of these parts under "Hydraulic Buffer," page 54.

*To replace centring collar, throttle valve or throttle valve spring.*—The system must be emptied as described on page 55 under "*To empty*"

*the recoil system.*" The centring collar, valve spring or throttle valve can then be drawn off the recuperator ram and replaced by new..

*To replace the ram packing.*—If, during the run-up of the howitzer, it is noticed that liquid is forced out through the holes in the dust caps at the rear end of the liquid cylinders, it denotes that the packing on the rams has become defective, and, if the leakage cannot be prevented by tightening up the compressed packing ring, or by the addition of a supplementary packing ring (if not already in use), the packing should be exchanged as follows:—

The recuperator system must be emptied, as described under "*To empty the recoil system*" on page 55. Remove the throttle valve with spring. Remove nut securing cylinder block to howitzer and force howitzer back along the cradle to give clearance in working (supporting the rear end of the cradle if necessary). Remove dust cap or caps and withdraw ram or rams to the rear. The packing should then be replaced by new and the fittings replaced in reverse order. Run up howitzer to firing position and secure to cylinder block by securing nut. Recharge the system as described below.

**NOTE.**—Before putting in new rubbers, care should be taken to see that they are smooth and free from flaws, and that they are clean and free from grit. They should be oiled all over immediately before assembling with a little of the same oil as is used in the recuperator.

After the recuperator system is assembled it should be entered into the recuperator cylinder and should be just tight enough to require to be gently tapped with a mallet of about 7 lbs. weight. It must not on any account be so tight as to require to be driven up the cylinder with hard blows. If it will not pass up the cylinder by moderate tapping, it should be taken out and examined to see if any parts are too tight.

#### HYDRAULIC BUFFER.

*To fill hydraulic buffer not fitted with tank:—*

- (i) Lash howitzer to cradle; remove depression stop; disconnect cut-off gear; remove nuts securing piston rod and recuperator rams; remove cradle cap; elevate howitzer about 5 degrees. (See WARNING "A").
- (ii) Remove plugs "A" and "C," attach "pump, liquid, portable, No. 1," to hole "C" by means of the "adapter, oil filling," measure out about 45 pints of oil, and pump in liquid till it overflows at "A."
- (iii) Bring howitzer horizontal, see that buffer is full, then, by means of the syringe, extract about one-tenth of a pint of oil.
- (iv) Replace plug "A," disconnect liquid pump and adapter, and replace plug "C."
- (v) Replace cradle cap and nuts securing piston rod and recuperator rams; connect up cut-off gear.
- (vi) Remove howitzer lashings and replace depression stop.

*To fill hydraulic buffer fitted with tank :—*

- (i) The procedure is generally similar to that for filling hydraulic buffers not fitted with tanks (except para. (iii)), with the following additional instructions :—
- (ii) Measure out about  $53\frac{1}{2}$  or  $62\frac{1}{2}$  pints of oil for *Mark VI* carriages and *Marks VII* and *VIIA* carriages respectively. These quantities include 8 pints for the tank.
- (iii) After filling buffer as described above, remove filling plug from tank and pour in remaining oil.
- (iv) When filling is completed, press knob on spindle or snifting valve to allow the escape from the buffer of any air which may have collected (*see Fig. 6*). (*See WARNING "J"*).
- (v) When buffer is full of oil and all air has been driven out, oil will flow out from knob of snifting valve spindle, if the knob is pressed (*see Fig. 7*).
- (vi) Replace filling plug of tank.

*To make up liquid to correct quantity after leakage.*—Leakage from the hydraulic buffer is automatically made up from the tank when such is fitted and is in operation, providing there is no air in the buffer which can be seen by working the snifting valve. The quantity of oil in the tank should therefore be noted from time to time, and the correct quantity maintained.

In the case of buffers without tanks, or where the tank is inoperative for some cause, proceed as described on page 53 for charging the hydraulic buffer.

*To tighten the glands.*—Lash howitzer to cradle; disconnect cut-off gear; remove cradle cap (*see WARNING "A"*); remove depression stop, and lay howitzer horizontal. Tighten the stuffing-box cap by means of the spanner provided and replace cradle cap, connect up cut-off gear, and replace depression stop.

*To replace the fibre washer or steel joint ring.*—Lash howitzer to cradle and disconnect cut-off gear (*see WARNINGS "A" and "H"*). Elevate howitzer to a position convenient for working, while retaining as much of the oil as possible in the buffer. Remove stuffing-box, catching any oil that may escape in clean receptacles. Replace defective washer or joint ring with new and replace stuffing-box. Refill buffer as described on page 53. Replace front cradle cap and connect up cut-off gear.

*To replace the L-leather or rubber rings.*—Lash howitzer to cradle, disconnect cut-off gear and cradle cap (*See WARNINGS "A" and "H"*) and remove cradle cap. Elevate howitzer to a convenient height for working, while retaining as much of the oil as possible in the buffer. Remove cap of stuffing-box and spiral spring. Remove stuffing-box, together with defective packing, care being taken to catch any oil that may escape in suitable vessels. Remove old packing, insert new, and replace parts in the reverse order. Opportunity should be taken to examine the steel joint ring and fibre washer and see that they are in good order. Refill buffer as described on page 53. Replace cradle cap and nuts securing piston rod and recuperator rams. Connect up cut-off gear.

When putting the L-leathers or rubbers in the stuffing-box, see that the flat surface is well bedded down to the metal. If this is not done the joint may leak and cause damage in the stuffing-box.

Where L-leathers are being used, see that they have the skin on the working surface, and that they are flexible and free from scratches. They should be well steeped in oil if possible before putting in, or well oiled by hand.

See that all parts are clean and free from grit before replacement.

*To replace compressed packing ring.*—If leakage occurs at the glands and tightening up the caps does not prevent it, a supplementary packing ring must be used, or, if a supplementary ring is already in use, the defective packing ring should be replaced by a new packing ring. This should be done as described for replacing the L-leathers or rubbers. Opportunity should be taken to see that the L-leathers or rubbers are in good order. (See WARNINGS "A" and "H").

The packing rings should be oiled all over with a little buffer oil immediately before assembling. The packing rings should pass over the piston rod with a moderate push. They should not be so slack that they will slip quite easily and not so tight as to require to be driven along the rod.

*To replace glands, gland sleeves or gland springs.*—The procedure for replacing these parts is generally similar to that described for replacing L-leathers or rubbers.

#### TO EMPTY THE RECOIL SYSTEM.

*To empty the hydraulic buffer :—*

- (a) Lash howitzer to cradle, disconnect cut-off gear, remove depression stop, remove front cap. (See WARNING "A").
- (b) Set cradle about horizontal.
- (c) (Remove filling plug from tank where fitted); remove stuffing-box and run off oil into clean receptacles.
- (d) Remove plug "C" to ensure draining piston rod.
- (e) Rock cradle up and down a few degrees to ensure draining tank where fitted and passages of control chamber.
- (f) Replace stuffing-box and plug "C."

*To empty the recuperator :—*

- (a) Lash howitzer to cradle; disconnect cut-off gear; remove depression stop; remove front cradle cap. (See WARNING "A").
- (b) Set cradle about horizontal.
- (c) Remove plug, adapter hole, "F," and open valve "G," and allow air pressure to escape.
- (d) Take off securing collars from rams and remove stuffing-boxes from both liquid cylinders, and run off oil into clean receptacles.
- (e) Remove plugs "H" to ensure draining recuperator rams.
- (f) Rock cradle up and down from a few degrees elevation to a few degrees depression to ensure draining H.P. cylinders.



- (g) When certain that no more oil is left in the H.P. cylinders, depress the front end of the cradle as much as possible by lifting the trail eye, in order to run all the oil out of recuperator passages.
- (h) Replace stuffing-boxes, plugs "H," and collars securing rams.

#### POINTS REQUIRING ATTENTION.

*Faulty run-out.*—Should the howitzer fail to run-out satisfactorily, this may be due to one or more of the following causes :—

- (i) Want of lubrication of gun slides.
- (ii) Air in buffer cylinder.
- (iii) Incorrect setting of valve-adjusting run-out.
- (iv) Weak recuperator.
- (v) Over-tightening of glands.

(i) *Want of lubrication of gun slides.*—See under "Care and preservation of howitzer, &c.," page 44.

(ii) *Air in buffer cylinder.*—This may be due to air which, as sometimes happens, has accumulated in the buffer cylinder owing to a small amount of air being sucked into the cylinder through the gland during run-up. Should this be so, press knob of snifting valve to liberate any air that may be held in compression in the cylinder, when the howitzer should move to the firing position.

(iii) *Incorrect setting of valve-adjusting run-out.*—Should the howitzer fail to run-out fully after the first round, this may be due to incorrect setting of the valve adjusting run-out situated in the rear of the cylinder block. Open valve; the howitzer should then move to the firing position. If the howitzer then fails to run-out, it should be forced into the firing position and another round fired. If the howitzer again fails to run-out fully, or should it remain at full recoil after the first round, the air pressure should be released, and the amount of liquid adjusted as described on page 53. The system should then be recharged with air.

The run-out should, under all conditions, be smooth and steady, without hesitation, vibration or bump. The speed of run-out can be regulated by the valve-adjusting run-out, which can be adjusted to give an easy run-out at either low, medium or high angles of elevation. Should the howitzer run-out with violence the valve should be screwed down until a satisfactory rate of run-out is obtained. If the howitzer runs out correctly at horizontal or low angles of elevation, it may be found that with an increase in range the run-out is too slow, in which case the valve should be opened to the extent found necessary. Similarly, a return to low angles of elevation may result in the howitzer running out with violence. The rate of run-out should therefore be watched, and, if necessary, slowed down by means of the valve until correct.

Care should be exercised in the manipulation of these and similar valves. These valves should be operated without any additional leverage.

(iv) *Weak recuperator*.—This may be due to loss of liquid through faulty packings or the loss of air owing to valve "G" not having been properly closed down or the plugs "D" and "E" not being properly screwed in. Every endeavour should be made to ascertain the true cause. The air pressure should be tested, and, if necessary, adjusted as described on page 52, or, if the air pressure is below 550 lbs. per square inch, 600-lbs. for *Marks VII* and *VIIA* carriages, and this is due to loss of liquid, the system should be emptied and recharged as described on page 53. (See WARNING "B").

(v) *Over-tightening of glands*.—Glands should be tightened up, if possible, when the cradle is warm, as the packings then compress better. The gland packings should not, however, be tightened up more than is necessary to prevent *excessive* leakage, as endeavours to entirely prevent leakage may lead to undue tightness, thus affecting the rate of run-up of the howitzer and causing excessive wear of the working parts.

*Faulty recoils*.—Frequent notice should be taken of the lengths of recoil, as shown by the recoil indicator on the left side of the cradle; the cut-off gear being adjusted, if necessary, by disconnecting the eye securing the connecting rod and turning it in the required direction, as indicated by engravings on the eye.

When checking the length of recoil, and before any adjustment of the cut-off gear is carried out, the following points should be noted:—

- (a) The length of recoil should be checked after a few rounds have been fired, as, owing to the equipment not having settled down, the recoils for the first round or two may be found below normal.
- (b) As firing proceeds, the length of recoil will, owing to the abnormal resistance set up in the recuperator by the increased pressure resulting from the rise in temperature of the liquid, tend to fall below normal. This tendency will be most noticeable when firing at low angles of elevation, as the proportion of the work done by the recuperator is then greater than that done by the hydraulic buffer, while at the higher angles of elevation the reduction will not be so noticeable as the proportion of work done is then reversed, *i.e.*, the greater part is done by the buffer.
- (c) Should excessive or violent recoils occur, these may be due to (i) a weak buffer, owing to insufficient liquid, (ii) a weak recuperator through loss of air pressure, (iii) a combination of both (i) and (ii), or (iv) incorrect setting of cut-off gear.
- (i) See that buffer is full. To ascertain this in the case of buffers fitted with tanks, elevate a few degrees and press knob of snifting valve. If buffer is full, oil will flow out from the spindle actuating the valve. In the case of buffers not fitted with tanks, or where the tanks are inoperative for some cause, proceed as for filling the buffer described on page 53. Where tanks are fitted

- see that tank is full. The oil level in the tank should never be accepted as an indication of the condition of the buffer, as oil will not flow from the tank into the buffer until all air in the latter has been liberated by operating the snifting valve. The only satisfactory proof of a full buffer is that, with the howitzer elevated a few degrees, oil flows from the spindle actuating the snifting valve on pressing the knob.
- (ii) If the adjustment of the liquid in the buffer fails to give satisfactory recoil, the air pressure should be tested, and, if found to be too low, should be replenished according to instructions given on page 52.
  - (iii) Proceed as in (i) and (ii) above.
  - (iv) To adjust the setting of the cut-off gear, proceed as under (references are to *Plate XXI*):—

*To ascertain the position of cut-off.*

*Preparation—*

- (1) (a) Open door of front cradle cap and measure from front face of recuperator body to front end of buffer piston rod (*X* on Fig. 2); this must be done in every instance, owing to variations in thickness of beating face.
- (b) Disconnect tank where fitted; remove howitzer.
- (c) Sink the trail spade or sole shoe until the trail bears on the ground or raise the wheels of the carriage to counteract for the height of the spade or shoe, level the carriage transversely, remove the depression stop and set the elevation indicator to zero.
- (2) Disconnect cut-off gear.
- (3) Remove cradle cap.
- (4) Remove front plug (stuffing-box) complete.
- (5) Run off buffer liquid.
- (6) Remove rear plug. This is optional, but facilitates operations.
- (7) Lash a stout plank to top of cradle (Fig. 1) and allow it to project about 6 feet beyond; suspend free end of buffer piston rod by means of a rope loop adjusted by wedges. This is necessary to ensure coincidence of axis of rod with that of cylinder, and thereby facilitates rotation of valve and rod. An alternate method is to support rod by means of a plank and wedges as shown (Fig. 1).

*Operation—*

- (1) Pull out piston rod until dimension A is as shown (Fig. 2).
- (2) Rotate piston rod until valve ports are just closed (Fig. 6). A light placed at rear end facilitates this.
- (3) Place a clinometer upon one flat of square, machined on end of rod (Fig. 1), having first removed all burrs, and record the angle obtained.

*To reproduce the position of cut-off.*

- (1) Assemble howitzer and cradle in the usual manner and see that the elevation indicator reads "O."
- (2) Connect up rod, actuating, and place clinometer upon the same flat of square at end of piston rod, as in (3) above, and adjust rod actuating, if necessary, until clinometer gives exactly the same reading as before in (3) above (Fig. 7).
- (3) Replace depression stop and connect up tank where fitted.
- (4) Refill buffer as described on page 53

*SIGHTING.*

The No. 7 dial sight when issued is in correct adjustment, water-tight and with all the cells and joints secured with fixing screws.

It is very unlikely that the interior will be required to be cleaned and the dial sight must on no account be taken to pieces, except by persons in possession of a certificate from the Ordnance College stating that they are qualified to do so.

The body of the dial sight must be cleaned with a clean soft cloth and a little oil, which must be rubbed off afterwards, care being taken that the glass is not touched.

The exterior of eyelens and window should be cleaned with chamois leather, specially kept for the purpose, and only by a competent person. Great care must be taken that no oil or grease is allowed to touch the glasses. Fingers, when apparently clean and dry, may leave marks on the lens which will impair the definition of the telescope.

Owing to the construction of the carrier the deflection arrangements should be occasionally tested for backlash by laying on a well defined object and traversing the sight right and left alternately by means of the deflection screw until the vertical crossline is aligned. If the deflection scale does not read the same in both instances, the difference of reading indicates the backlash.

Backlash may be due to the small coned portion of the carrier which is removed when inserting the sight in its carrier having become strained or not fitting properly.

To correct this, the removable portion of the coned surface of the carrier may perhaps be made to fit more perfectly by manipulating its fixing screws. If this fails, the coned surface of the removable portion should be slightly reduced with fine emery paper or a dead smooth file.

## LIST OF LUBRICATING HOLES.

| Fittings which are provided with Oil Holes for Lubricating Purposes. | No. of Holes. | Position of Holes.                                                                                                                                  |
|----------------------------------------------------------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| HOWITZERS.                                                           |               |                                                                                                                                                     |
| Bearing B.M. lever ... ..                                            | 1             | On top side of carrier.                                                                                                                             |
| Safety shutter ... ..                                                | 1             | On top left side of carrier.                                                                                                                        |
| Carrier hinge joint ... ..                                           | 1             | On top of hinge pin.                                                                                                                                |
| Breech screw and pintle of carrier                                   | 1             | On top side of breech screw.                                                                                                                        |
| CARRIAGES.                                                           |               |                                                                                                                                                     |
| Cradle ... ..                                                        | 10            | 3 on each side for howitzer slide, 1 in each side at front end for lubricating recuperator slide, and 2 in cradle cap for lubricating cut-off gear. |
| Gear, brako ... ..                                                   | 2             | 1 in each crosshead.                                                                                                                                |
| Gear, elevating—<br>Arc ... ..                                       | 1             | Over trunnion.                                                                                                                                      |
| Gear, operating sight—<br>Bracket supporting sight ...               | 1             | In top of bearing.                                                                                                                                  |
| Gear, quick loading ... ..                                           | 5             | 1 on right plunger socket, 2 on left plunger socket, and 1 in each side of bracket cross-shaft.                                                     |
| Gear, traversing—<br>Case, spur wheel and pinion...                  | 3             | 1 for spur wheel, 1 for pinion, and 1 for bearing handwheel spindle.                                                                                |
| Cover, traversing screw ...                                          | 2             |                                                                                                                                                     |
| Link-nut ... ..                                                      | 1             |                                                                                                                                                     |
| Saddle—<br>Capsquares (2) ... each                                   | 1             | On top.                                                                                                                                             |
| Case, elevating and traversing gears                                 | 7             | 1 for worm, 1 for spindle (worm), 1 for bearing handwheel, 1 for spindle are pinion, 1 for bearing sight bracket, and 2 in clip portion of case.    |
| Clip, rear, right ... ..                                             | 2             | 1 at each end.                                                                                                                                      |

## STORES CARRIED ON CARRIAGE.

| Articles.                        | No. | Remarks.                          |
|----------------------------------|-----|-----------------------------------|
| Cleaner, piassaba ... ..         | 1   | On left side of trail             |
| Brush, rammer and sponge ...     | 1   | On left side of trail             |
| Can, lubricating, No 9 ... ..    | 1   | On left side of trail             |
| Handspikes, lifting ... ..       | 4   | On top of trail.                  |
| Rimers, vent, axial ... ..       | 2   | In pocket on right side of trail. |
| Sight, dial, No. 1 ... ..        | 1   | On right side of saddle.          |
| Staves, end and intermediate ... | 2   | On right side of trail.           |
| Tray, loading ... ..             | 1†  | On top of trail.                  |

† Not required for carriages provided with loading bogie.

## STORES CARRIED ON LIMBER.

| Articles.                       | No. | Remarks.                       |
|---------------------------------|-----|--------------------------------|
| Axe, felling ... ..             | 1   | On front of limber.            |
| Axe, pick ... ..                | 1   | Under limber.                  |
| Box, grease ... ..              | 1   | Under limber.                  |
| Brush, water, carriage ...      | 1   | Under limber near side front.  |
| Can, lubricating, No. 3...      | 1   | Under limber near side rear.   |
| Hook, bill ... ..               | 1   | Under limber, off side, front. |
| Rifles, in covers, in clips ... | 2   | On front of limber.            |
| Ropes, drag, heavy ... pairs    | 1   | On splinter bar.               |
| Shovels ... ..                  | 2   | On side of limber.             |

## STORES CARRIED IN LIMBER BOX.

| Articles.                                      | No.  | Remarks. |
|------------------------------------------------|------|----------|
| Adapter, pressure gauge, with cap ... ..       | 1    |          |
| Box, obturator ... ..                          | 1    |          |
| Gauge, pressure, No. 5 ...                     | 1    |          |
| Measure, filling hydraulic buffer ... ..       | 1    |          |
| Pins, keep, split (in tin box) box             | 1    |          |
| Spanners—                                      |      |          |
| No. 1 ... ..                                   | 1    |          |
| No. 2 ... ..                                   | 1    |          |
| No. 3 ... ..                                   | 1    |          |
| No. 4 ... ..                                   | 1    |          |
| No. 7 ... ..                                   | 1    |          |
| No. 8 ... ..                                   | 1    |          |
| No. 9 ... ..                                   | 1    |          |
| No. 12 ... ..                                  | 1    |          |
| No. 13 ... ..                                  | 1    |          |
| No. 14 ... ..                                  | 1    |          |
| No. 15 ... ..                                  | 1    |          |
| No. 16 ... ..                                  | 1    |          |
| No. 17 ... ..                                  | 1(b) |          |
| No. 21 ... ..                                  | 1    |          |
| No. 22 ... ..                                  | 1(a) |          |
| No. 24 ... ..                                  | 1    |          |
| Spanner, travelling carriages,                 |      |          |
| No. 23 ... ..                                  | 1    |          |
| Tommy, No. 38 ... ..                           | 1    |          |
| <i>Carried in tray, No. 1.</i>                 |      |          |
| Buffer, hydraulic—                             |      |          |
| Rings, compressed packing ...                  | 2    |          |
| Rings, packing, L-section, stuffing box ... .. | 2    |          |
| Spring, gland ... ..                           | 1    |          |

(a) Not for 8-inch howitzer Mark VI. equipment.  
(b) Not for 8-inch howitzer Mark VII. equipment.

## STORES CARRIED IN LIMBER BOX (continued).

| Articles.                                                            | No. | Remarks. |
|----------------------------------------------------------------------|-----|----------|
| Washers, packing, stuffing box and control cylinder ...              | 2   |          |
| Washers, air and filling plug (2 to a set) ...                       | 4   |          |
| Washers, plug, adjusting run out ...                                 | 4   |          |
| Gear, elevating and loading—                                         |     |          |
| Spring, plunger, left ...                                            | 1   |          |
| Spring, plunger, right ...                                           | 1   |          |
| Recuperator—                                                         |     |          |
| Rings, compressed packing ...                                        | 2   |          |
| Rings, packing, L-section, stuffing-box ...                          | 8   |          |
| Rings, packing, U-section ...                                        | 12  |          |
| Spring, gland ...                                                    | 1   |          |
| Spring, spiral ...                                                   | 1   |          |
| Spring, valve throttle ...                                           | 2   |          |
| Washers, packing stuffing-box ...                                    | 4   |          |
| Washers, air and overflow plugs ...                                  | 4   |          |
| Washers, plug, adapter pressure gauge ...                            | 6   |          |
| Washers, plug, adapter hole and plug, overflow (4 to a set) ...      | 1   |          |
| Washers, connection, adapter, oil filling ...                        | 4   |          |
| Washers, plug, adapter, pressure gauge ...                           | 2   |          |
| Washers, cap, adapter pressure gauge ...                             | 2   |          |
| Washers, connection, pressure gauge ...                              | 2   |          |
| <i>Carried in tray, No. 2.</i>                                       |     |          |
| Bit, vent... ..                                                      | 2   |          |
| Funnel, filling cylinder, No. 3...                                   | 1   |          |
| Screwdriver, adjusting sights, No. 1 ...                             | 1   |          |
| Spanners—                                                            |     |          |
| No. 5 ...                                                            | 1   |          |
| No. 6 ...                                                            | 1   |          |
| No. 10 ...                                                           | 1   |          |
| No. 11 ...                                                           | 1   |          |
| Spanner, adjusting sights, No. 1                                     | 1   |          |
| Spanner, adjusting sights, No. 3                                     | 1   |          |
| Spanner, adjusting sights, No. 4                                     | 1   |          |
| Tommy, carriage, travelling, B.L. 6-inch gun and 8-inch howitzer ... | 1   |          |
| Tool, withdrawing split pins ...                                     | 1   |          |
| Wrench, breech mechanism, No. 137 or 138 ...                         | 1   |          |



## PART VI.

## MISCELLANEOUS STORES.

**Bearer, projectile.**—Consists of a wood stave with two hooks and a swivel secured midway between the two ends. The hooks and swivel enable the shell to be carried by means of a selvagee from the supply depot to the howitzer.

**Bit, vent.**—This is of round steel furnished with a spiral bit at one end and hardened at the point; the opposite end is formed into a loop for convenience in handling. It is used for removing obstructions from the vent channel and for cleaning it.

**Borer, vent, axial, .303-inch, chamber.**—The borer is of steel, shaped to suit the chamber for "Tube, percussion, S.A. cartridge", in the axial vent. The front end of the borer is serrated for removing obstructions of a hard nature from the tube chamber. The other end of the borer is provided with a cross handle.

The borer is used with percussion lock "P.H." mechanism.

**Box, obturator.**—The box is of wood with metal bolt and fly nuts to hold two obturators and adjusting discs.

**Brush, rammer and sponge.**—This combined side arm performs the duties of a cleaner for the chamber in addition to that of a rammer. The brush portion consists of bristles fixed on brass rings, which are held between two wood collars having a brass lining. The sponge is in two portions separated by the brush; each portion consists of tufts of wool secured to a brass lined stock of wood. The rammer is of hard wood, the exposed surface being protected by a copper covering; it is secured to the stave by a copper rivet. A sleeve to which the rear portion of the sponge is attached is secured to the stave by copper rivets and is provided at the rear end with two nuts, which hold the complete head firmly together.

**Cleaner, Piasaba, No. 15.**—The cleaner head is of elm fitted with tufts of piasaba; it is mounted on a manganese bronze spindle having a looped securing nut with keep pin at the front end and a socket for stave at the rear end. It is suitable for either lanyard or stave, a joint plug being inserted in the socket when for use with the latter.

**Compressor, Air, Portable** (*Plates XXXVI and XXXVII*).  
—The compressor, which is hand-driven, comprises a No. 2 two-stage vertical air pump, mounted in a stand.

The two-stage air pump consists of the following principal parts:—

Piston.

Eccentric (or crank) shaft.

Two eccentric rods (or straps).

Gudgeon pin.

Flywheel.

Sprocket and chain wheels.

Water-cooled cylinder, with drain hole and plug for emptying purposes when compressor is not required for use.

Five valves.

The piston is in the form of a double ram. It is connected to the eccentric shaft by means of an eccentric rod fitted at each side of the gudgeon pin. A flywheel is fitted to one end of the eccentric shaft, whilst a small sprocket wheel (14 teeth) is attached to the opposite end.

The large (low-pressure) suction valve, with plug, cap and cover, is fitted horizontally at the bottom of the cylinder.

A small valve, with plug, cap and cover, is also fitted horizontally to the bottom of the cylinder, but on the opposite side, and opposed to the large valve in action, thus allowing the expulsion of the air drawn in by the low-pressure piston.

On the top of the cylinder a bye-pass valve is fitted horizontally, and two small valves, with caps, plugs and covers, fitted vertically; one of the latter allows the passage of the first-stage compressed air into the high-pressure cylinder and the other the expulsion of the doubly-compressed air into the recuperator cylinder of the mounting, through the bye-pass valve.

The stand is provided with two winch handles, two cranks for winch handles, and a winch handle shaft, which connects to the eccentric shaft of the pump by means of sprocket wheels and chain.

Lubrication is effected by means of an adjustable sight-feed lubricator connected by a pipe to the large (low-pressure) suction valve; also by the grease cup fitted to each of the two eccentric rods.

#### CARE AND PRESERVATION.—ALSO RUNNING INSTRUCTIONS.

All gearing, shaft bearings and driving chain must be kept well lubricated and free from dirt and grit as far as possible.

Before starting the compressor to work an outside examination should be made to see that the machine is clean and that no damage has occurred during transit.

**The jacket should be filled with water and kept filled when in use; this is most important to prevent overheating.**

The lubricator feeding into the first-stage suction valve must be set to feed at the rate of about four drops per minute and in the case of pumps not fitted with air filter, the cover "37" on the suction inlet should be screwed back three or four turns, and the compressor is then ready for use.

If the machine is working in an exposed position during frosty weather and is stopped and allowed to stand for any length of time, the jacket should be drained through the drain plug "35" provided for that purpose. If this is not done the cylinder may be fractured by frost.

When starting up again, if the jacket is empty, do not forget to refill it.

To keep the compressor in good working order it should be worked daily; half a dozen turns of the handles should suffice for this. It should also be kept covered to prevent dust getting into the working parts. This is most important.

The working pressure for this machine is up to 600-700-lbs. per square inch, and should there be any falling off of the supply of delivered air the valves should be examined to see if they are clean; if they are

found to be gritty, the valves and springs should be removed and cleaned. If necessary, grind valves lightly to seats; coat with clean, thin oil before replacing. If efficiency of pump is not improved the piston rings should be examined and compressor head lifted off its base; rings should be taken out of piston grooves and tried in the cylinders. If spring of rings is destroyed the rings should be exchanged. When assembling the parts care should be exercised in seeing that all parts are clean and free from grit.

The joints between main cylinder and base and cylinder cap and cylinder should be carefully made with brown paper soaked in oil.

Grease cups are provided for the working parts, and these should be kept charged with semi-solid grease.

Dismantling and examination can be carried out in the following manner:—

Both the second-stage valves are placed in the top cover and are easily accessible by removing the caps "19" and plugs "20."

The first-stage suction and delivery valves are placed horizontally and are equally accessible by removing the caps and plugs.

It will be seen that the first-stage delivery and the second-stage suction and delivery valves, together with their seats, plugs and caps, are interchangeable.

To examine the main bearings in the pedestal, remove the key "33" and the flywheel; the split pins and washers from the gudgeon pin "10," when the eccentric straps "6" can be removed from the eccentrics. The eccentrics should then be drawn off the feather keys, the latter removed from the shaft and the shaft drawn out of the bearing.

To withdraw the piston for examination, remove the securing pin "32," draw the gudgeon pin "10," unscrew the four nuts on the bottom flange of the water jacket, when the top part of the machine can be at once removed and the piston drawn out endways.

When charging, it is better to continue running the compressor from start to finish, changing men if fatigued, about every three minutes, without stopping. Should a stop be necessary the compressor will be much easier to start if the recuperator valve is closed and the bye pass valve "36" opened on the delivery pipe. In that case, as soon as the compressor is started again, the valve "36" must be closed and the recuperator valve opened. If pump is in good working order the recuperator should be charged to 600-lbs. in about 15 to 20 minutes.

When the compressing operation is finished open bye-pass valve "36," taking care that the valve on the recuperator is first securely screwed down; also see that suction cover "37" is screwed up hand-tight to prevent dirt getting in and that the feed lubricator is turned off.

When compressors are fitted into housings with hand wheels and chains complete, a means of tightening the chain is provided by placing washers underneath the base of the compressor, which washers can be removed and the compressor lowered to the extent of  $\frac{3}{16}$ -inch to take up any slack on the chain due to wear or stretching of the same.

The following data is a guide to locating faults :—

If no pressure is obtainable the fault may be due to one of the following causes :—

*External faults.*

- (1) Release valve open, meshes of wire gauze choked, or in the case of pumps not fitted with filter probably suction cover not screwed back.
- (2) Pipe or adapter joints, cylinder cover, or valve caps leaking.

*Internal faults.*

- (1) The L.P. inlet or L.P. delivery valves faulty, or valve seat joint defective.
- (2) Packing rings of L.P. or H.P. piston defective, or cylinders scored.
- (3) Air leak into water belt—due to faulty joint.

If pump is not working satisfactorily (with suction cover open), i.e., pressure rising slowly, the defect may be due to any of the above causes. Should the fault occur at high pressure it will be more probably due to defective H.P. delivery valve, H.P. packing, or scored H.P. cylinder.

Before charging recuperator it is advisable to test the pump system as follows :—

- (1) Close air-charging valve on recuperator.
- (2) Work pump slowly till gauge registers 500 or 600-lbs. per square inch.
- (3) If the system is in good working order the gauge hand should now be stationary or only "creeping" back very slowly—the latter being permissible.

Should the hand fall quickly, the system should be examined for external faults ; if unable to locate the fault, it may be tested by smearing black wheel grease over joints, when air bubbles will be observable where there is a leak.

*NOTE.—Great care should be exercised in using the gauge. When taking or releasing the pressure, the valve should be opened gently in order to prevent damage to gauge.*

In all correspondence relating to the machine the number of the machine should be quoted, and where spare parts are required the code words or numbers should be given.

**Cover, Cradle Cap.**—The cover, which is of service colour waterproof canvas, is formed to fit over the cradle cap, and is secured in position by two white line lashings stitched to the top of the cover inside a hem and, running in opposite directions, pass to the outside through two eyelets fitted in the side of the cover. Three holes are formed in the bottom for drainage purposes.

**Cover, Breech.**—The cover is made of waterproof canvas and shaped to suit the breech of the howitzer. It is provided with a leather strap for securing it when in position.

**Cover, Muzzle, No. 5.**—The cover is made of waterproof canvas shaped to suit the muzzle of the howitzer, and provided with a leather or canvas strap for securing it in position.

**Cover, Rocking-bar Sight, No. 1.**—The cover, which is made of double thickness service colour waterproof canvas, is formed to protect the rocking-bar sight. It is provided with an opening at one side, and is secured when in position by a lace of white line passing through brass eyelets fitted at intervals round the edges.

**Funnel, Filling Cylinder, No. 3.**—The funnel, which is of block tin, is provided with a bent spout to fit into the filling holes of the buffer and recuperator.

**Hawser, Wheel Purchase.**—The hawser, which is made of 3-inch galvanised steel wire rope, and provided at each end with a steel thimble and hook, is for use with parbuckling ropes to prevent them from being cut and frayed by the sharp edges of the tractor wheels.

**Implements, Ammunition, Key, No. 8, Marks II\*\*, III\* and IV.**—The No. 8 key is used with large and medium base plugs and fuzes. It consists of a steel bar, circular in section, except at the centre, where it is rectangular, and about 18 inches in length. In the centre of the bar and on three sides of it are two projections, which are made to fit the slots in the large and medium base percussion fuzes respectively. The other side of the bar is formed with a square projection, which is made to fit the recesses in the large and medium base plugs.

**Implements, Ammunition, Key, No. 10 (Mark I)—Nos. 17 and 44 Fuzes.**—The key is of steel, with a screwdriver at one end, and a projection on one side to fit the square hole in the cap of the fuzes for fixing purposes. The projection has a semi-circular notch cut in it to clear the knot of the safety pin of the No. 44 fuze. It is fitted with a loop of white cotton line.

**Implements, Ammunition, Key, No. 16.**—The *Mark II* key is made of steel, with a projection at one end to engage in the slot in the body of the "Adapter 2-inch fuze hole, No. 2," and "No. 101E and 106 fuzes" for fixing purposes. It is fitted with a loop of white cotton line.

The *Mark I* differs from the *Mark II* in having two horns, one on each side of the projection.

This key will be superseded by the No. 53.

**Implements, Ammunition, Key, No. 17.**—This key is for fixing No. 188M fuzes. The *Mark II* is made of steel, with a circular end bevelled on the underside to suit the fuze, and is provided with a projection to engage in the square slot in the flange of the fuze body.

The *Mark I* differs from the *Mark II* in having only the underside fitted for use.

**Implements, Ammunition, Key, No. 18.**—This key is for use in setting No. 188M fuzes.

The *Mark II* is made of steel and is similar in shape to the No. 17, but is provided with a prong on its underside to engage with the stud on the lower time ring. It is fitted with a white cotton lanyard.

The *Mark I* key differs from the *Mark II* in the ring portion being of lesser depth, and consequently does not take such a good seating on the fuze.

**Implements, Ammunition, Key, No. 32.**—This key is similar to the No. 17, *Mark II*, key, except that it is double handed and instead of the projection for fixing the *Marks I* to *III* fuzes being formed solid in the key, it is made separately of hardened steel, wedge shaped and driven into the key.

It is heavier and stronger than the No. 17.

**Implements, Ammunition, Key, No. 48.**—PLUGS, AND No. 83 FUZES.—The key is of steel and consists of a plain bar of steel, 10-inches long,  $\frac{3}{8}$ -inch wide, having the ends slightly rounded off. It is for use in removing or inserting plugs having suitable slots, also with the slotted cap of the Fuze T., No. 188M.

**Implements, Ammunition, Key, No. 53, Mark III.**—The key is made of bar steel, with both ends shaped semi-circular on the same side of the bar. The ends have screwed-in pins with hexagonal heads, with screwdriver slot across the top to facilitate replacement at any time. The pins are secured by grub screws.

The inside of the ends is chamfered on both edges to permit of its use for both inserting and removing fuzes, one end being for No. 106 fuzes and the other for the No. 101 series of fuzes and adapter No. 2.

Earlier marks of this key are obsolete for future manufacture.

**Implements, Ammunition, Key, No. 59.**—This key is for use in removing G.S. fuze hole plugs, also for G.S. special and 2-inch fuze hole plugs, except 2-inch No. 3 *Marks IV* and *V* and No. 8.

It is made of steel. It is double-handed, and consists of a 15-inch round bar passing through a centre portion, having a circular base recessed to fit over the plugs, a projecting rib being formed across the centre of the recess to engage in the key slots on the top of the plugs.

A slightly tapered square projection is formed on the top of the centre portion for use with plugs having square recesses.

**Implements, Ammunition, Key, No. 62.**—The key is made of  $\frac{1}{4}$ -inch flat steel, with a T-shaped handle, and blackened in oil. The end of the stem has two projections formed to engage in the key slots of the adapter, 2-inch fuze hole, No. 12. A hole is drilled through the centre to take a  $\frac{1}{2}$ -inch diameter tommy.

**Lanyard, Firing, No. 33.**—The No. 33 firing lanyard is of flexible steel wire rope, 6 feet long, with steel wedge fork and toggle. Two studs are provided in the side of the fork, which also serves as a tool in assembling and dismantling the striker spindle. This firing lanyard is for use with percussion lock "P.H." mechanism.

**Lanyard, Firing, No. 35.**—The No. 35 firing lanyard is made of hemp rope, 57 inches long, with steel firing peg, loop and wood



toggle. The firing peg is of round steel, having a loop formed on one end for the attachment of the lanyard.

This firing lanyard is for use with the Martini-Metford percussion lock.

**Lifter, Projectile.**—The lifter, which is of steel, consists of two grips, one end of which is forked, with the ends of the fork cross-grooved to prevent the projectile slipping, the other end of the grip fitting into a handle and secured by rivets; a stop plate is provided which is formed to fit over the grips, and is kept in position by an axis bolt on which the grips hinge. The handles, which are of tubular steel, are plugged at the ends with wood.

**Measure, Filling Hydraulic Buffer, No. 1.**—This measure is of tin and holds one gallon. There are ribs round the inside surface by which 1 quart, 1 pint,  $\frac{1}{2}$  pint and  $\frac{1}{4}$  pint may be measured. The lower end is provided with a spout and fitted tap. It is fitted inside with a wire gauze strainer.

**Press, Obturator, Gauge, thickness, obturator. Tommy, press, obturator.**—The press and gauge are intended for use in reforming obturators which have become so distorted as to cause difficulty in placing them in position on the axial vent in the howitzer.

The press consists of a steel body, shaped internally to suit the contour of the obturator and fitted with a steel cover. The cover is secured by means of a steel bolt with disc spring washer and cross-handle. The bolt is provided with a square head, by means of which the press can be held in a vice while the cross-handle is revolved when compressing or releasing the obturator. A steel tommy is provided for use with the cross-handle in compressing the obturator. Recesses are formed round the periphery of the press so as to admit of the application of the gauge for testing the thickness of the obturator while under compression.

The gauge is of flat steel plate, and is for use in testing the thickness of the obturator.

**Pump, Liquid, Portable.**—This pump is used to fill the buffer and to charge the recuperator with liquid. It consists of a cylindrical steel bucket provided with a lid. There are brackets inside the bucket, in which the pump is secured by a bayonet joint. The pump proper consists of a vertical cylinder divided into two chambers, in one of which works a packed plunger actuated by a grip handle at the top. The lower end of the pump is perforated for the entrance of liquid, which enters into the plunger chamber through an inlet valve. The bottom of the second chamber is fitted with a delivery valve and its top end has a screwed delivery nozzle, to which is attached a length of flexible hose, which connects the pump to the buffer or recuperator.

**Rimer, Vent, Axial, 303-inch Chamber, No. 2.**—The No. 2 rimer is of bronze and steel, the bronze portion being shaped to suit the chamber for "Tube, percussion, S.A. cartridge," and having flats formed on it for removing residue from the chamber. The shank is of steel and furnished with a crosshandle. The No. 2 rimer is used with percussion lock "P.H." mechanism.



No. 1 rimer, which is generally similar to the No. 2 rimer described above, but has a double joint in the shank portion, can be used with percussion lock P.H. firing mechanism in lieu of No. 2.

**Slings, Projectile.**—The sling, which is designed to carry one projectile, is for use in place of boxes when transporting shell in carts and wagons.

It consists of four wood battens braced together by two bands of webbing. A handle and base are formed by webbing fixed to the web bands. A short length of line is provided to secure the projectile in the sling.

**Stave, End, No. 15.**—The end stave is of ash, 7 ft. 3 in. long, and fitted with a metal  $1\frac{1}{2}$ -in. joint at one end to engage the socket of the intermediate stave.

**Stave, Intermediate.**—The intermediate stave is for insertion in the socket of the cleaner. It is of ash and is fitted at one end with a metal joint plug, and at the other with a joint socket to suit the end stave. The length is 6 ft.

**Syringe, Extracting Liquid.**—The syringe consists of a body and spout of tin. In the body works a packed plunger. Its capacity is one-tenth pint of liquid. It is used to extract a small quantity of liquid from the buffer after the latter has been filled.

**Tray, Loading.**—The tray is of steel, semi-circular in shape, furnished at the front end on the underside with a gunmetal frame for engaging the lower interruptions in the breech opening. The rear end of the tray is turned up so as to form a stop against which the base of the projectile rests when being carried in the tray. It is provided on the underside with two brackets for the bearers. The bearers are tubular in section and are riveted to the brackets at the inner ends, the outer ends being cranked and furnished with supporting brackets to facilitate handling. The outer ends of the bearers are provided with leather hand grips and wood plugs. The bearers are connected on the right and left sides by gunmetal guide bars which are shaped to rest on the side plates of the cradle to support the tray in the correct alignment for loading.

**Wrenches, Breech Mechanism.**—The following wrenches are used with the breech mechanism:—

No. 137.—For nut vent axial, and pin actuating plate retaining breech screw.

No. 138.—For screws fixing control arc and rotating cam, screw securing B.M. lever bearing, screw fixing B.M. lever catch plate, and nut for crank shaft.

The No. 199 wrench is of steel, having at one end a spanner, which is not required for use with this equipment, and provided at the other end with a bronze end piece with rivets for use when assembling and dismantling the box slide "V." The wrench is for use with percussion lock "P.H." mechanism.

## PART VII.—AMMUNITION.

| Projectiles.                                 |           |             |                  |                        |                                  | Nature of Fuze.                                                                                                                                                                                                                                                                                        | Cartridges.                                                                                                  |                       |         | —     | Means of firing.                      |                                  |
|----------------------------------------------|-----------|-------------|------------------|------------------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-----------------------|---------|-------|---------------------------------------|----------------------------------|
| Description.                                 | Mark. (a) | Fuze Hole.  | Bursting Charge. |                        | Average weight filled and fuzed. |                                                                                                                                                                                                                                                                                                        | Nature.                                                                                                      | Weight.               | Size.   |       |                                       |                                  |
|                                              |           |             | Nature.          | Weight. with exploder. |                                  |                                                                                                                                                                                                                                                                                                        |                                                                                                              |                       |         |       |                                       |                                  |
| Shell, B.L. High Explosive, 8-inch Howitzer. | XIIA      | 2 in.       | H.E.             | lb. oz. dr.<br>31 9 8  | lb. oz. dr.<br>200 0 0           | Fuze, percussion, with cap, No. 106 brass or steel body or No. 106 E. (b).<br>Fuze, percussion, No. 101 B. (b).<br>Fuze, time, No. 188 M., with adapter, No. 12 and Gaine, No. 2 (for air ranging).<br>Fuze, percussion, base, large, bronze, No. 16.<br>Fuze, percussion, with cap, No. 106 or 106 E. | Cordite, M.D. or R.D.B. and Cordite, M.D.T. or R.D.B.T. (c).<br>N.C.T. (e).<br>N.C.T. (e) (d).<br>N.C.T. (e) | lb. oz. dr.<br>9 5 12 | 8       | 20-10 | For Mark VI Howitzer only.            | Tube, percussion S.A. cartridge. |
|                                              | (f)       | "           | "                | 15 7 4                 | " " "                            |                                                                                                                                                                                                                                                                                                        |                                                                                                              |                       |         |       |                                       |                                  |
|                                              | XIIIA     | "           | "                | 18 6 12                | " " "                            |                                                                                                                                                                                                                                                                                                        |                                                                                                              |                       |         |       |                                       |                                  |
|                                              | XIV       | "           | "                | 17 0 0                 | " " "                            |                                                                                                                                                                                                                                                                                                        |                                                                                                              |                       |         |       |                                       |                                  |
|                                              | XV        | "           | "                |                        |                                  |                                                                                                                                                                                                                                                                                                        |                                                                                                              |                       |         |       |                                       |                                  |
| Shell, B.L. Common Pointed, 8-inch Howitzer. | IA        | Base, large | Shellite, 60/40  | 15 12 0                | " " "                            |                                                                                                                                                                                                                                                                                                        |                                                                                                              |                       |         |       |                                       |                                  |
| Shell, B.L. Chemical, 8-inch Howitzer.       | IA        | 2-in.       | ...              | ...                    | " " "                            |                                                                                                                                                                                                                                                                                                        | Cordite, M.D. or R.D.B. (c)<br>N.C.T. (e)                                                                    | 17 8 0<br>20 3 8      | 8<br>16 |       | For Marks VII to VIII Howitzers only. |                                  |

(a) Other Marks may be met with.

(b) Fuzes supplied in the proportion of 60 per cent. 106 type (instantaneous) and 40 per cent. 101 B with delay.

(c) Spare igniters are issued, where authorized for use with these charges.

(e) Flash-reducing charges are issued, where authorized for use with these charges.

(d) Obsolete for future manufacture.

(f) For Marks VII to VIII howitzers.

## SHELL, B.L., HIGH EXPLOSIVE, 8-INCH HOWITZER, MARK XIIA.

(Plate XXXVIII).

The *Mark XIIA* shell consists of a forged steel body with tapered walls and a head struck with a radius of 4 calibres; the latter is fitted with a fuze hole bush threaded to the 2-inch fuze hole gauge and prepared to take an exploder container.

A copper driving band is fitted into an undercut groove near the base, the groove having four waved ribs to prevent the band turning on the shell. The base, which is solid, is fitted with a steel plate disc screwed or riveted in.

The *Mark XIIIA* shell differs chiefly from the *Mark XIIA* in having parallel walls and in being fitted with a base adapter.

## SHELL, B.L., HIGH EXPLOSIVE, 8-INCH HOWITZER, MARK XIV.

The *Mark XIV* shell is of forged steel with parallel walls and a 2-calibre radius head which is fitted with a fuze hole bush threaded to the 2-inch fuze hole gauge and prepared to take an exploder container.

The base is solid and is fitted with a steel plate disc screwed or riveted in. A copper driving band is fitted into an undercut groove near the base, the groove having five waved ribs to prevent the band turning on the shell.

The *Mark XV* shell (Plate XXXIX) differs chiefly from the *Mark XIV* in being fitted with a base adapter.

## SHELL, B.L., COMMON POINTED, 8-INCH HOWITZER, MARK IA.

(Plate XL.)

The *Mark IA* shell is of cast or forged steel with a 4-calibre radius head; the walls of the shell are parallel, tapering off at the shoulder.

The cavity is threaded at the base to take a base adapter which is threaded internally to receive the fuze and externally to take a base cover-plate in two parts consisting of a screwed ring and perforated plate. Six holes are bored through the perforated plate to allow the gas to act on the pressure plate of the fuze.

A copper driving band is fitted into an undercut groove near the base: the groove has four waved ribs to prevent the band from turning on the shell.

## SHELL, B.L., CHEMICAL, 8-INCH HOWITZER, MARK IA.

(Plate XLI.)

This is a converted *Mark XIIA* H.E. shell from which it differs in the head being prepared to take an exploder container for the bursting charge: the container is threaded internally to the 2-inch fuze hole gauge.

A tapering charging hole is drilled in the body of the shell below the shoulder, the hole is closed after charging by driving in a steel charging hole plug.

## FUZES.

## INSTRUCTIONS RELATING TO THE CARE OF NO. 106 AND 106E FUZES.

1. *The (safety) cap of the No. 106 and 106E fuzes must be removed and the wire seal broken only immediately prior to firing.*
  2. *If a No. 106 or 106E fuze has become uncapped in any manner except that referred to in (1) or has the wire seal inadvertently broken, it is to be regarded as unfit for firing and is to be withdrawn from use.*
  3. *Fuzes withdrawn, under paragraph (2), are to be examined to ascertain if the brass tape under the hammer head is present and correct, if this is so, the (safety) cap should be replaced and secured in position by a becket, and the fuze returned to the Ordnance Store for transmission to Woolwich. If examination shows that the brass tape is incorrect, or missing, the fuze may be in a dangerous condition and must be destroyed under expert supervision.*
- In securing the (safety) cap with the becket, difficulty may arise with fuzes, where the body is not provided with an eye through which the becket may be threaded, in such cases, wooden pegs should be driven in the fixing key holes in the body and the becket fastened round these.*
4. *It is essential that the becket should be fastened in such a manner, so as to prevent the cap coming off in transit to Woolwich. The method of fastening the fuze-cap is as shown on Plate XLIII A.*

## FUZE, PERCUSSION, WITH CAP, NO. 106E.

(Plate XLII.)

The *Mark IV* fuze consists of the following principal parts:—Body, cap, hammer, steel collar in halves, brass tape with weight, steel and dermatine washers, copper shearing wire, steel guide pin, detonator holder, detonator, magazine with shutter, shutter spring, bottom screwed cap, shalloon and paper discs.

The *body*, which is made of bronze, is screw-threaded externally at its lower end to suit the 2-inch fuze hole gauge. Its upper end, which is generally conical in shape, terminates in a cylindrical stem, which is screw-threaded to receive the cap. Slots are cut in the body to receive the No. 53 key for fixing purposes. The body is further prepared to receive a shearing wire, guide pin and countersunk hole to take the wire securing the cap. A groove is cut round the shoulder for punch stabbing the fuze into the shell when fuzing the latter.

Internally the body is bored out in different diameters to receive the hammer, detonator holder and magazine.

The *hammer* is of steel, fitted with an aluminium head. The lower end is pointed to form a needle. Just below the head a recess is bored to take a stud on one-half of the steel collar and in one side a slot is cut through which fits the shearing wire and guide pin. The hammer is placed in position from the top of the fuze body passing through a steel washer on the top of the latter. The guide pin is screwed into the body, one end entering the slot in the hammer. The shearing wire passes through the body and hammer, the ends being afterwards turned over. The function of the guide pin is to prevent the hammer

turning whilst the tape is being wound or unwound, while the shearing wire keeps the hammer clear of the detonator after the cap has become detached until the shell strikes. Around the hammer, under the head and resting on the steel washer of the body, is a steel collar in halves, one-half of which has a pin to fit the recess in the hammer and around this again is wound a brass tape to one end of which is soldered a weight. The top of the fuze is then closed by a  $\cap$  shaped steel or malleable cast-iron cap which screws on to the projection at the top of the body against a dermatine washer, and is held in position by a steel wire which passes through an eye in the cap, the two ends being twisted, a complete turn is then taken round the cap and the loose ends inserted in the hole provided in the body and fixed therein by a lead plug pressed in.

The *steel collar* and tape prevent the hammer moving on to the detonator until they have been freed by the rotation of the shell during flight, and so prevent any possibility of a premature in the bore or near the muzzle.

The *detonator holder* is held in position by the top surface of the magazine. Its upper end is recessed to receive the detonator, which is held in position by the mouth of the holder being spun over. A cupro-nickel or brass disc is placed on top of the detonator. An opening is bored through the centre of the holder which is filled with loose "composition, exploding," the opening being closed by a paper disc shellaced to the bottom of the holder.

The *magazine* is screwed externally to suit the interior of the body and is reduced in diameter near the bottom and screwed to receive the bottom cap. The top of the magazine is recessed and fitted with a shutter and spring which swings open when the fuze is spun during flight. The bottom of the magazine is bored out to contain a compressed C.E. pellet and is closed by the bottom cap.

A set screw is screwed into a hole in the body of the fuze and holds the magazine in position.

*Preparation of fuze.*—To prepare the fuze the wire is broken, and the cap unscrewed and removed at the moment of loading.

*Action.*—On de-acceleration after leaving the bore the rotation of the shell causes the weight on the tape to fly outwards, causing the latter to become unwound from the steel collar; the latter in turn drops off, leaving the hammer supported only by the shearing wire.

The rotation of the shell during flight causes the shutter to swing outwards until a hole formed in it comes into line with the central perforation in the detonator holder and on impact the hammer is driven in, breaking the shearing wire and piercing the detonator. The consequent detonation passes through the loose "composition, exploding," in the detonator holder to the magazine, which in turn detonates the charge in the shell.

The *Mark IV<sub>D</sub>* fuze differs from the *Mark IV* in being fitted with a brass disc over the detonator.

The *Mark IV'S* fuze differs from the *Mark IV*, in the head of the hammer being made of steel, instead of aluminium.

Packed one in a tin cylinder No. 101F with exploder.

## FUZE, PERCUSSION, WITH CAP, No. 106.

(Plate XLIII.)

This fuze is generally similar to the No. 106E described above from which it differs principally in not having a removable magazine with safety shutter.

## FUZE, PERCUSSION, No. 101B.

(Plates XLIV-XLVI.)

The *Mark II* fuze consists of the following principal parts: Body, cap, graze pellet, detonator plug, detonator, needle, creep spring, paper cylinder, centrifugal bolt, detent, detent spring, safety shutter and adapter.

The *body* is made of metal, it is screwed externally at the base to the 2-inch fuze hole gauge, the upper part being conical in shape and fitted with a cap which is screwed in. It is bored out from the head to receive the graze pellet, below this chamber a fire channel is bored leading to the shutter recess.

A second chamber is bored parallel to the fire channel to receive the detent and its spring and is closed at the base by a screwed plug. Across the upper part a hole is bored at right angles to receive the centrifugal bolt and is closed by a screwed plug.

Around the body are two knurled bands, the upper one painted black denotes that no cocked pellet is fitted as in the No. 100 fuze, the lower one red, to distinguish it from the No. 101E fuze, which has stronger detent and shutter springs.

Two slots are made to receive a key for fixing purposes.

A lip is formed on the flange for the purpose of punch stabbing the fuze into the shell.

The body is bored out from the base and screwed to receive an adapter.

The *cap* is screwed externally at the base to fit the body and recessed to receive the head of the creep spring, it is bored out from the head, recessed and screwed to receive a steel needle.

The *graze pellet* is cylindrical and is screwed internally at the base to receive the detonator plug. The head is stepped to form seatings for the centrifugal bolt and creep spring.

The *detonator plug* forms a support for the detonator.

The *detonator* consists of a copper cup containing 1.7 grains of fulminate composition with brass discs at top and bottom and closed by a copper or glazeboard washer, the whole being held in the cup by the edge of the latter being spun over it.

The *creep spring* is inserted between the underside of the cap and the head of the graze pellet, it holds the detonator off the needle during flight.

The *centrifugal bolt* is fitted into the chamber at the side of the body which is closed by a screwed plug. The inner end fits over a shoulder in the top of the graze pellet.



The *detent* consists of a body and pin connected by a ball and socket joint, the pin passes up behind the centrifugal bolt and is kept in position by a spiral spring, the chamber is closed at the base by a screwed plug and at the top by a sealing ball of brass or copper, which is inserted after inspection of the empty fuze.

A *paper cylinder* lined with tinned plate is inserted in the fire channel between the graze pellet and the shutter.

The *adapter* is screwed externally at the head to fit the fuze and internally to receive the gaine, a recess is bored out across the head to receive the shutter. The adapter is secured into the fuze and the gaine into the adapter by a set screw.

The *safety shutter* consists of a rectangular plate slotted at the inner end to receive the stem of a detent, at the outer end is a spiral spring to keep it in position.

The shutter is fitted into a recess in the head of the adapter and covered with a tinned plate cap with a flash hole in the centre, a metal disc being inserted below the shutter with a similar flash hole in it. The shutter opens when the shell is spun at between 1,500–2,000 revolutions per minute.

"J" or "K" adapters which have modified forms of cap and are fitted with shutters opening when the shell is spun at between 1,300–1,700 revolutions per minute may also be fitted. In which case the letters "J" or "K" will be added to the Mark.

*Action*.—On shock of discharge the detent sets back compressing its spring and freeing the centrifugal bolt, the latter on the rotation of the shell flies outwards and unlocks the graze pellet.

On de-acceleration after the projectile has left the bore the shutter is also moved outwards by the centrifugal force compressing its spring, in moving it releases its detent which drops down and keeps the shutter clear of the flash holes.

During flight the graze pellet is prevented from moving by the creep spring, but on impact it moves forward carrying the detonator on to the needle. The flash from the detonator passes through the fire channel to the gaine which detonates the bursting charge.

#### FUZE, PERCUSSION, BASE, LARGE, BRONZE, No. 16, MARK IV.

(Plate XLVII.)

The *Mark IV* fuze consists of the following parts :—Body, detonator pellet, pressure plate, screwed cap, protecting ring, centrifugal bolt, three springs, pea ball, small retaining bolt, locking pellet, steel needle, detonator plug, set screw for cap, retaining bolt for pea ball, screwed pin and four closing plugs.

The *body*, which is of aluminium bronze, is turned and screwed on the exterior to suit the shell ; the interior is bored out and screwed, the bottom of the bore being coned and recessed for the detonator pellet. A hole is bored through the side of the body to receive the small end of the centrifugal bolt and closed by a screwed plug ; a hole is also bored through the opposite side of the body to receive the small retaining bolt and is closed by a screwed plug. A third hole is bored and screwed at an angle of 45° to the first hole to receive



the screwed pin for the detonator pellet. Further holes are bored, one to receive the retaining bolt for pea ball and two others longitudinally, one for the channel which contains five powder pellets and the other for the pressure plate; a hole is also bored from the powder pellet channel to the centre of the body. The top of the body has a circular recess for a compressed powder ring and two elongated holes are cut in the base for screwing in the fuze.

The interior of the detonator pellet is bored out and screwed at the top to receive the detonator plug and detonator and a flash-hole is bored through. A hole is bored at right angles to the axis for the centrifugal bolt and further holes for the brass pin of the centrifugal bolt, locking pellet and small retaining bolt. The exterior of the pellet at the top is recessed to form a seating for the spring and the bottom is reduced in diameter, forming a cone with flange and stem to suit the interior of the body. A slot in the pellet engaging with a pin screwed into the body prevents the pellet turning in flight.

The *detonator* contains about 3 grains of composition.

The *pressure plate* is of copper; it is cupped and has a lip round the edge to form a gas-check. Near the top the spindle of the plate is reduced in diameter to enter the slot in the small retaining bolt when in flight.

The *steel protecting ring* is screwed into the recess in the base below the pressure plate and secured by punch stabs.

The *screwed cap* has a curved top and the lower part is reduced in diameter and bored out to accommodate the spring and threaded to suit the body. The centre of the cap is threaded to take a steel screwed needle, and six fire-holes are bored through the flange; the cap is secured by a set screw.

The *centrifugal bolt* is fitted with a brass pin which engages in a hole in the detonator pellet to prevent the bolt turning; a flash-hole is bored through the stem of the bolt.

The *small retaining bolt* prevents any movement of the centrifugal bolt except when in flight.

The *pea ball* seals the channel in the body containing the powder pellets and is held in position by its retaining bolt with spring.

The *locking pellet*, on impact, locks the detonator pellet in the forward position, it being forced into the recess for the centrifugal bolt in the body through the action of its spring.

The fuze requires no preparation before loading.

*Action*.—On discharge, the gas pressure crushes in the pressure plate, carrying forward the spindle, thus bringing the reduced diameter of the spindle opposite the small retaining bolt. The rotation of the shell causes the bolts to move outwards; the slot in the small retaining bolt fitting round the reduced part of the spindle allows the centrifugal bolt to withdraw its projecting end from the recess in the body and to bring its vertical flash-hole in line with the fire channel in the pellet. At the same time the retaining bolt in the base of the fuze, acted upon by centrifugal force, moves outwards, compressing its spiral spring, thus allowing the pea ball to move out of its seating and open the fire channel in the base.

On graze or impact the detonator pellet moves forward, overcoming the spring and carrying its detonator on to the needle at the same time withdrawing the flange round its base from the groove in the bottom of the percussion chamber.

The locking bolt, engaging with the recess in the body, retains the pellet in the forward position and thus allows the flash from the detonator to pass down through the channel in the centrifugal bolt and pellet, through the hole left open by the pea ball, to the powder pellets in the vertical channel, thus firing the magazine in the front end of the fuze, the flash from which, passing through the six fire-holes in the cap, explodes the bursting charge of the shell.

Packed one in a tin cylinder, No. 11, F.

Weight, 2 lbs. 8½ ozs.

#### FUZE, TIME, No. 188M, MARK V.

(Plate XLVIII.)

This fuze is converted from Fuze T and P, Nos. 83 or 88.

The *Mark V* fuze consists of the following parts, which are made of metal unless otherwise stated; Body, top and bottom time rings, cap, base plug, needle and spring of steel, with detonator pellet for the time arrangement and wood block.

The cap and base plug may, alternatively, be made of steel.

The lower part of the body is screwed to suit the 2-inch fuze hole gauge; above this is a platform and stem to receive the time rings; the top of the stem of smaller diameter is screwed externally to receive the cap, which is slotted to receive the Key No. 48 or a screwdriver for clamping purposes. A chamber bored out from the top of the stem contains the time-lighting arrangement and the base of the body is bored out to form a chamber which is fitted with a wood plug (in place of the percussion arrangement of the Nos. 83 and 88 fuzes); below this the body is bored out to form a magazine containing a perforated powder pellet and is closed with a base plug; a channel is bored from the magazine communicating with the bottom time ring.

The fuze is graduated from 0 to 22, subdivided into tenths.

A double-pointed needle is screwed into the diaphragm between the time-lighting chamber and the lower chamber. The top ring is secured to the body by two brass pins; the bottom ring is provided with a lug for setting purposes.

The time arrangement consists of the upper needle with a steel spiral creep spring, above which is the pellet holding the detonator; a flash hole communicates with the top time ring.

The top ring has a channel bored out and filled with No. 83 fuze composition, and the bottom ring with R.D. 202 composition; a flash hole is bored between the two rings, and both rings have gas escape holes which are covered with asbestos and brass discs shellaced in.

The flash holes are filled with perforated powder pellets, and the channel leading to the magazine with loose powder.

A leather washer is fitted to the body below the flange.

*Action.*—On shock of discharge the time detonator pellet sets back on to the needle and ignites the composition in the top ring; this

burns round and communicates by the flash hole with the bottom ring, which burns the reverse way and fires the composition in the channel leading to the magazine, the flash of which passes into the shell.

The fuze is marked as follows :—

Red band round lower part of cap, denoting magazine filled with powder pellet. Lower time ring lacquered red, denoting that it is filled with R.D. 202 composition. Blue "T" on side denoting that the percussion arrangement has been omitted.

The fuze is fitted with a rubber cover and packed one in a cylinder.

Key No. 18 is used for setting and No. 17 or 32 for fixing purposes.

Mean time of burning, set full after correcting for barometer—48 seconds.

#### ADAPTER, 2-INCH FUZE-HOLE, No. 12.

This adapter is made of steel, and is for use with time fuzes and No. 2 gaine in H.E. shell.

It is screwed on the exterior to the 2-inch fuze-hole gauge for a certain distance, below which it is turned plain. A hole is bored out from the bottom and screwed to receive a No. 2 gaine and a groove is cut across the top to accommodate a shutter, which is retained in position by a perforated tinned plate cap soldered to the top of the adapter.

#### GAINE No. 2.

The gaine, which acts as an exploder to H.E. shell, is made of steel and consists of a hollow cylinder containing explosive. The cylinder is screwed externally at one end to suit the screwed recess of the adapter with which it is used. The screwed end of the cylinder is closed with a shellaced disc and the opposite end with a screwed plug or cap.

CARTRIDGE, B.L., 8-INCH HOWITZER, 9 LB. 5 OZ. 12 DR. CORDITE, M.D., SIZE 8, AND M.D.T., SIZE 20—10.

(Plate XLIX.)

The *Mark III* cartridge consists of four sections made up as follows :—

|                      |    |    |    |    | lb. | oz. | dr. |
|----------------------|----|----|----|----|-----|-----|-----|
| No. 1 section (core) | .. | .. | .. | .. | 3   | 14  | 12  |
| " 2 "                | "  | "  | .. | .. | 0   | 13  | 10  |
| " 3 "                | "  | "  | .. | .. | 1   | 6   | 6   |
| " 4 "                | "  | "  | .. | .. | 3   | 3   | 0   |
| Total                | .. | .. | .. | .. | 9   | 5   | 12  |

No. 1 section (or core) consists of Cordite M.D. in two lengths contained in a silk cloth or cream serge bag, which is shaped to form the base and stalk of the core. To the base is stitched an igniter "C" consisting of two discs of shalloon and one of silk cloth divided into four parallel compartments and filled between the shalloon discs with 3 oz. of R.F.G.<sup>2</sup> or S.M.<sup>1</sup> powder; a silk or shalloon braid lifting becket is stitched to the other end of the core.

Nos. 2, 3 and 4 sections of Cordite M.D.T. are each contained in oval shaped bags which fit around the stalk and rest upon the base of the core, being secured to the latter by two pieces of silk or shalloon braid.

The sections are marked 1, 2, 3 and 4 for identification purposes.

The *Mark II* cartridge differs only from the above in the nature of cordite used.

Packed two in a "Cylinder, Cartridge, No. 43," or eight in a "Box, Cartridge, B.L. 60-pdr."

CARTRIDGE, B.L., 8-INCH HOWITZER, 10 LB. 12 oz, N.C.T. 16.

(Plate L.)

The *Mark I* cartridge consists of four sections made up as follows :—

|               |                |    |    |    | lb. | oz. | dr. |
|---------------|----------------|----|----|----|-----|-----|-----|
| No. 1         | section (core) | .. | .. | .. | 4   | 8   | 0   |
| " 2           | " "            | .. | .. | .. | 0   | 12  | 8   |
| " 3           | " "            | .. | .. | .. | 1   | 12  | 8   |
| " 4           | " "            | .. | .. | .. | 3   | 11  | 0   |
| Total .. .. . |                |    |    |    | 10  | 12  | 0   |

This cartridge differs chiefly from the 9 lb. 5 oz. 12 dr. cordite charge described above in having sections 2, 3 and 4 stitched to the stalk in four places, two at the top and two at the bottom, in place of two pieces of shalloon braid, and in having an igniter "D" which differs only in dimensions from the "C" igniter described above.

Packed two in a "Cylinder, Cartridge, No. 43."

CARTRIDGE, B.L., 8-INCH HOWITZER, 12 LB. 9 oz. 4 dr., N.C.T. 22.

The *Mark I* cartridge differs only from the 10 lb. 12 oz. charge described above in the weights of the sections, which are as follows :—

|               |                |    |    |    | lb. | oz. | dr. |
|---------------|----------------|----|----|----|-----|-----|-----|
| No. 1         | section (core) | .. | .. | .. | 5   | 9   | 12  |
| " 2           | " "            | .. | .. | .. | 1   | 1   | 4   |
| " 3           | " "            | .. | .. | .. | 1   | 13  | 0   |
| " 4           | " "            | .. | .. | .. | 4   | 1   | 4   |
| Total .. .. . |                |    |    |    | 12  | 9   | 4   |

CARTRIDGE, B.L., 8-INCH HOWITZER, 14 LB., N.C.T. 20 (SUPERCHARGE).

The *Mark I* cartridge consists of 14 lbs. N.C.T. 20, contained in a single silk cloth bag to one end of which is stitched an igniter and to the opposite end a silk or shalloon braid lifting becket. Two pieces of silk or shalloon braid are tied round the cartridge after filling. The igniter is similar to that described for the 10 lb. 12 oz. charge.

Packed two in a "Cylinder, Cartridge, No. 43."

CARTRIDGE, B.L., 8-INCH HOWITZER, 17 LB. 8 OZ. CORDITE M.D. OR  
R.D.B., SIZE 8.

(Plate LI.)

The *Mark III* cartridge consists of six sections made up as follows:—

|               |                |    |    |    | lb. | oz. | dr. |
|---------------|----------------|----|----|----|-----|-----|-----|
| No. 1         | section (core) | .. | .. | .. | 5   | 7   | 0   |
| " 2           | " "            | .. | .. | .. | 1   | 3   | 10  |
| " 3           | " "            | .. | .. | .. | 1   | 15  | 14  |
| " 4           | " "            | .. | .. | .. | 4   | 14  | 0   |
| " 5           | " "            | .. | .. | .. | 1   | 15  | 8   |
| " 6           | " "            | .. | .. | .. | 2   | 0   | 0   |
| Total .. .. . |                |    |    |    | 17  | 8   | 0   |

No. 1 section (or core) consists of Cordite M.D. or R.D.B. of various lengths contained in a silk cloth or cream serge bag which is built up in two different sizes, one part forming the base and the other part the stalk of the core. To the base is stitched an igniter "E" consisting of two discs of shalloon and one of silk cloth divided into four parallel compartments and filled between the shalloon discs with 6 oz. of R.F.G.<sup>2</sup> or S.M.<sup>1</sup> powder; a shalloon braid lifting becket is stitched to the other end of the core.

Nos. 2, 3 and 4 sections are each contained in oval-shaped bags which fit around the stalk and rest upon the base of the core, being secured to the latter by two pieces of shalloon braid.

Nos. 5 and 6 sections fit around the stalk above Nos. 2, 3 and 4 sections and are secured in a similar manner.

The sections are marked 1, 2, 3, 4, 5 and 6 for identification purposes.

Packed four in a "Box, Ammunition, 3-inch 20 cwt." or one in a "Cylinder, Cartridge, No. 51" or two in "Cylinders, Cartridge, No. 36" or "50."

CARTRIDGE, B.L., 8-INCH HOWITZER, 20 LB. 3 OZ. 8 DR. N.C.T., SIZE  
16.

The *Mark I* cartridge consists of six sections made up as follows:—

|               |                   |    |    |    | lb. | oz. | dr. |
|---------------|-------------------|----|----|----|-----|-----|-----|
| No. 1         | section (or core) | .. | .. | .. | 6   | 3   | 4   |
| " 2           | " "               | .. | .. | .. | 1   | 8   | 4   |
| " 3           | " "               | .. | .. | .. | 2   | 3   | 0   |
| " 4           | " "               | .. | .. | .. | 5   | 14  | 8   |
| " 5           | " "               | .. | .. | .. | 2   | 3   | 0   |
| " 6           | " "               | .. | .. | .. | 2   | 3   | 8   |
| Total .. .. . |                   |    |    |    | 20  | 3   | 8   |

This cartridge is generally similar to the 17 lb. 8 oz. cordite charge described above, differing chiefly in having an igniter "F" which is generally similar to the "E" igniter described above.

Packed one in a "Cylinder, Cartridge, No. 50."

## TUBE, PERCUSSION, S.A. CARTRIDGE, MARK I.

*(Plate LII.)*

This tube is used with guns or howitzers having modified firing mechanism. The form and general dimensions are shown on Plate LII.

It consists of a body with cap and cork disc.

The body and cap consist of the .303 rifle cartridge-case filled with a charge of 30 grs. S.M.<sup>1</sup> powder. It is closed at its front end with a cork disc which is covered with shellac varnish before insertion and the exposed side afterwards waterproofed with shellac.

Packed 20 in a "Box, Tube, Percussion, S.A. Cartridge."

## NOTES.

In the event of a tube failing to ignite a charge, care should be taken in extracting the fired tube not to stand directly in rear of the howitzer, as the gas generated will cause the tube to fly out with some violence so soon as the lock is clear.

The vent channel sometimes becomes choked with residue from the cartridge. When this occurs the taper portion should be cleared with a "Rimer," sufficiently to allow of the insertion of a tube, which, when fired, will remove the rest of the obstruction.

## TUBE, PERCUSSION, S.A. CARTRIDGE, DRILL, MARK I.

The drill tube consists of a .303-inch cartridge case with the anvil removed from the cap chamber and the body filled with a wood plug secured by the neck of the case being indented into it in three places.

Three elongated indents equally spaced are formed in the case and fitted with red paint to distinguish it from the service tube.

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(As to prices in brackets, see top of page 2.)

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